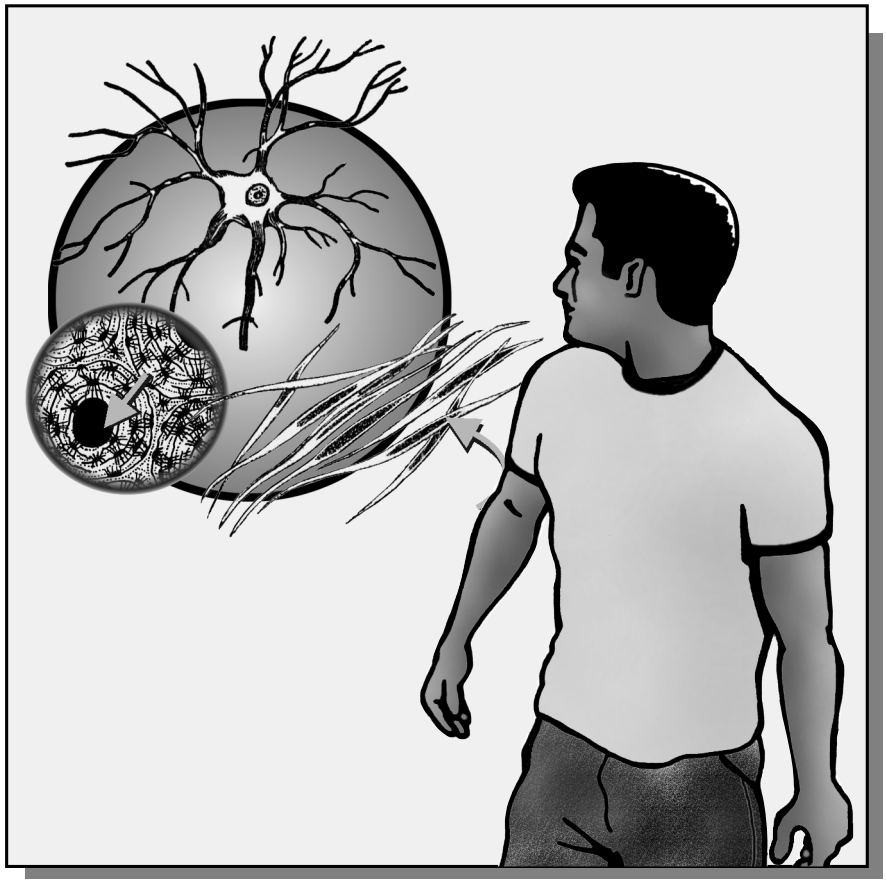
Natural Science Mysteries



Chapter 5

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Natural Science
Mysteries

Chapter 5

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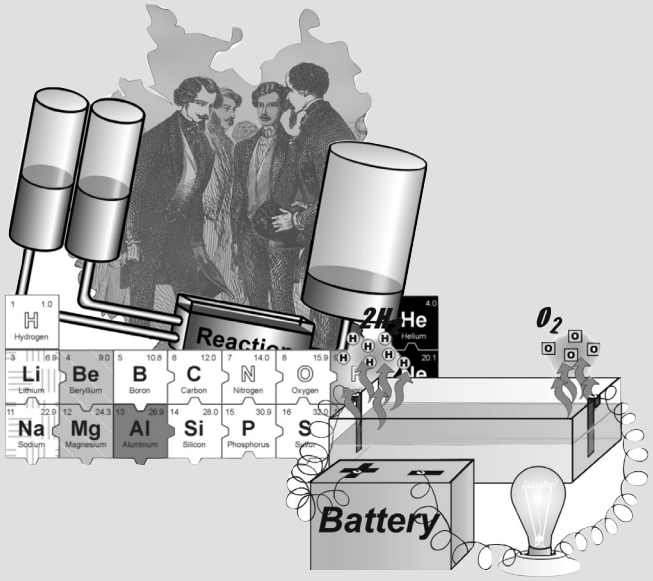
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"By knowledge, understanding and wisdom the true mysteries of life unfold as they are studied line by line and precept upon precept." —Ronald E. Johnson, C.Ph.D.



Lesson 1
Biology

Chapter 5

Features of Land and Aquatic Vertebrates

Section 1

Lessons 1-5

FISH AND OTHER VERTEBRATES



The summer passed quickly for Bryan and Tom as they worked on the nature reserve on Danger Island. One day, Ranger Eldridge introduced a new ranger and announced, "I must attend training at the home office. While I am away, Ranger Lemon Stewart is in charge." 1

Ranger Lemon Stewart impatiently tapped a clipboard he carried. He said, "I have a list of things for you boys to do." 2

During the next few days, Bryan and Tom learned quickly that Lemon Stewart attached great importance to his checklist of tasks. One of his assignments was for the boys to make signs for the trails. The ranger said, "We want to mark the trails with new signs and arrows." 3

Tom voiced concern about the timing of the project. "The season is nearly over. They'll be exposed to the elements all winter." 4

Peevishly, Ranger Stewart said, "It is not your position to question my assignments! Your job is to finish them correctly and on time." 5

"Then, we'll need the combination to the lock on the tool shed for the equipment," said Bryan. 6

Ranger Stewart countered, "I'll open the shed for you." He walked with the boys to the building, then hid the combination lock with his body as he twirled the dial. The ranger opened the door and hung the opened lock on a nail on the side of the building. He told the boys, "When you finish, lock the door securely." 7

The tool and supply shed had a concrete floor and floor-to-ceiling shelves filled with equipment, but no windows. Bryan pulled out the compact, gasoline-powered electric generator. He and Tom got the engine started and plugged in the electric router. 8

VOCABULARY

Bilaterally symmetric: having two sides that are identical in appearance; most vertebrates have bilateral symmetry

Vertebrate: animal with a backbone; fish, amphibians, reptiles, birds and mammals are vertebrates

Fish: a vertebrate that lives in the water and breathes oxygen with gills; the plural of fish takes two forms as either "fish" (referring to same species) or "fishes" (referring to two or more species)

9 Tom set up the template for guiding the router as it cut circular wooden disks. He understood that arrows were to be painted on both sides of the wooden disks so they could be turned either way to face left or right equally well. The arrows were to be symmetric. The boys worked efficiently together. Tom routed the signs and Bryan painted them.

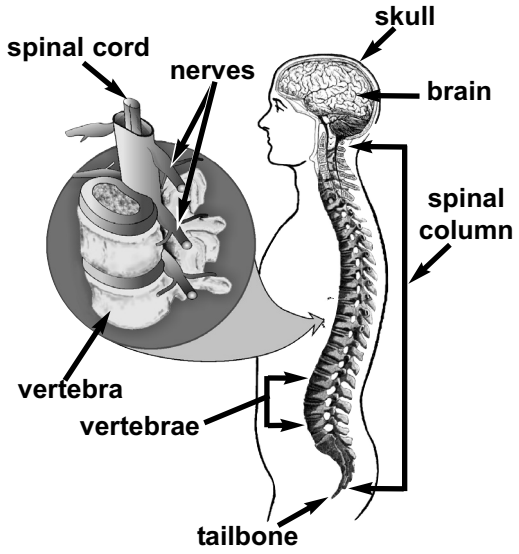
10 The word *symmetric* means "same measure." Vertebrates, animals with backbones, are ***bilaterally symmetric***. The human body has bilateral symmetry. Except in cases of deformity, accident or injury, the human body has two ears, two eyes, two arms and two legs. The prefix *bi* means "two". The human body has two sides that are the same. They are symmetric. If you draw a line from the top of the human body down the middle, then each of the two sides will look the same. When a fish is sliced along its length, each half has the same number of eyes and fins. Most fish, like all other vertebrates, are bilaterally symmetric.

VOCABULARY

Vertebra: any one of the individual bones that make the backbone of a vertebrate; plural is *vertebrae*
Spinal column: the spine or backbone; the *vertebrae* that enclose the spinal cord
Spinal cord: the part of the central nervous system that lies within the bones of the vertebrae
Llamas: domestic mammals of South America that are raised for their wool and serve as beast of burden
Gills: organs that allow fish to extract oxygen from water; gills have membranes that allow the two-way passage of gases from water into the bloodstream and from the bloodstream into water
Lateral line: a sense organ along each side of a fish that detects pressure changes
Air bladder: a gas or oil filled bladder that helps fish float at a desired depth; also known as a *swim bladder*
Cartilage: a tough but flexible material that makes up some parts of the skeleton of most vertebrates; the skeleton of sharks is made entirely of cartilage

11 The animal kingdom has about two million species that have been identified. Several million more may exist that have not been fully studied. Of that number, only 45,000 are ***vertebrates***. Despite being a small part of the total, probably no other group of animals is as thoroughly studied as the animals with backbones. ***Fish***, amphibians, reptiles, birds and mammals are all vertebrates.

Human Nervous System



12 The backbone of a vertebrate is made of a series of ***vertebra*** bones. Together, they are the *vertebrae* composing the ***spinal column*** that houses the **spinal cord**, which is part of the nervous system. The central nervous system is protected by the skull and includes the brain, sense organs such as the eyes and ears, and nerves that go from sense organs to the brain. The brain responds to the information gathered by the sense organs, activates the muscles, and sends instructions to the organs. Messages to and from the brain travel along the spinal column.

13 Unlike invertebrate insects with their hard outer coverings, vertebrates have internal skeletons. Because the skeleton in a vertebrate grows along with the animal and does not

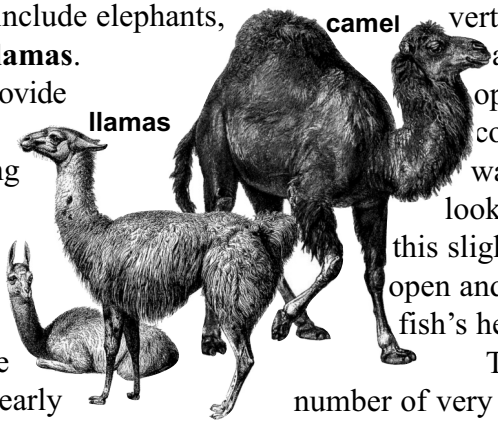
have to be shed during growth, a vertebrate can grow larger than an invertebrate. A fully-grown bull elephant weighs about six tons. A fully-grown blue whale weighs about 200 tons. Both are vertebrates.

14 One of the most important parts of the skeleton is the skull. It provides a safe housing for the brain and the main sense organs such as those for seeing, hearing and smelling.

15 For muscles to work, they must have firm anchors. In most vertebrates, the muscles are anchored to the bones of the skeleton. In addition to the bones that give support in the arms and legs, a rib cage protects vital organs such as heart and lungs.

16 Although they have no exterior skeleton like the insects, all vertebrate creatures are covered with protective skin. Some vertebrates have additional protection such as scales, feathers, fur or hair that grows from the skin.

17 One of the reasons vertebrates are studied so closely is because they have a great economic impact on our daily lives. Throughout history, vertebrates have been used in many ways as important sources of food and energy. In many parts of the world, the muscle power of animals lightens work for humans. Working animals are used to transport heavy loads and include elephants, camels, oxen, horses and **llamas**. Vertebrate skins and furs provide clothing and accessories. Dogs are trained for hunting and pulling sleds through snow. Goats and cattle provide milk. Exotic-looking creatures such as peacocks and gazelles serve decorative purposes; and nearly any vertebrate can become a pet. In ancient history, birds were trained as hunters and messengers. Hawks and falcons were trained to hunt for food. Carrier pigeons were used to send messages.



18 Fish are an important source of food protein. They also provide recreational fishing. Exotic fish like goldfish are decorative and kept in aquariums.

19 Fish are vertebrates that live in water. They have fins for swimming and scales for protection. Fish are well designed for moving easily through water. The scales overlap and angle back toward the tail. Fish have streamlined shapes to reduce resistance of water. A fish flips its tail fin back and forth to provide thrust. Most of the energy that drives a fish through water comes from the tail fin. The other fins keep the fish upright in the water, provide fine control or act as brakes.

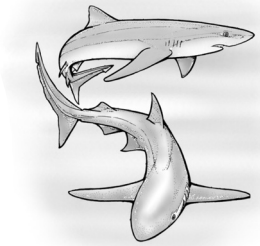
20 Like any other vertebrate a fish has a four chambered heart that pumps blood through arteries. The arteries branch into smaller and smaller blood vessels. Capillaries are the smallest blood vessels and carry blood to individual cells. On the other side of the cells, capillaries merge to give larger vessels; then empty into the veins for the return trip to the heart and ***gills***.

21 Like land animals, fish require oxygen to survive. They extract oxygen, dissolved in the water, with their gills. The gills of fish play the same role as lungs of land based vertebrates. Watch a fish in an aquarium. You will see it opening and closing its mouth constantly to force a flow of water through the gills. By looking closely, you can detect this slight motion of the gills as they open and close on both sides of the fish's head.

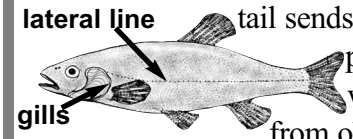
22 The gills are made of a vast number of very thin membranes. They are folded so that a tremendous amount of surface area fits in a small space. The membranes are filled with a fine network of blood vessels. The membrane design allows gases to flow from water to blood and from

blood to water. Oxygen dissolved in the water passes into the blood where it is taken to the rest of the body. The blood carries waste gases released by the cells to the gills. The waste gas is primarily carbon dioxide. As oxygen enters the blood from the gills, carbon dioxide passes out into the water.

23 Fish have the same senses as other vertebrates including sight, hearing, smell, taste and touch. Each is important to the fish. For instance, some fish have a keen sense of smell. When a predator injures a minnow, the injured fish gives off an odor that the other minnows detect. They scatter in alarm. Catfish use their whiskers, which provide a sense of touch and taste, to feed along the bottom of water that is too murky for them to see clearly. Fish can also hear, although they have no external ears. Instead, the sense of sound is located within the skull. The sound is conducted directly to the ear from the water through the skull.

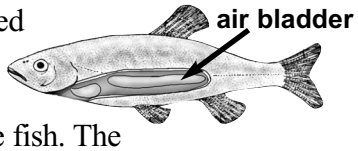


24 The ***lateral line*** is a special sense organ to detect changes in pressure. Water is a fluid that transmits pressure easily. As a fish swims, the action of its tail sends out pressure waves that reflect from obstacles and other fish. The lateral line detects waves, allowing the fish to avoid brushing against an object. The fish can sense a predator and flee, even before the enemy is seen. Fish that travel in schools turn together because of the pressure wave produced by other fish in the group.



25 You can see the lateral line on many fish. The series of pores make a visible strip along the full length of the fish on both sides. The pores connect to nerves that terminate in microscopic, hair-like nerve endings. Changing water pressure causes the "hairs" to wiggle. Nerves transmit the information to the fish's brain.

26 The ***air bladder*** helps a fish stay at a particular depth without additional effort. The air bladder is located inside the fish, near the center balance point of the fish. The bladder contains a gas, usually oxygen. The bladder controls buoyancy so that the fish stays at the right depth without floating upward or sinking. Some fish use the air bladder as a resonating chamber to make sound. For example, if a fish grinds its teeth together, the bladder amplifies the sound. The drum fish makes a sound like that of a distant, muffled drum.



27 A few types of fish, such as sharks do not have air bladders.Without air bladders fish must swim constantly to maintain their desired depth. A shark also differs from other fish in that its skeleton is not made of bones. Instead, the shark skeleton is ***cartilage***, a tough but flexible material. In the human body, cartilage makes up part of the nose and outer ears, and acts as cushioning material between the vertebrae in the backbone.

28 The boys had eaten a large breakfast, so they decided to skip lunch and work until the afternoon break. Bryan said, "We may be able to finish by then."

29 The boys finished by the mid-afternoon break, and sat down on the worktable to eat their lunches. Ranger Stewart appeared as they finished. "I see you are taking a long lunch hour—or should I say a two-hour lunch!"

LIFE PRINCIPLE



"The most gracious way to disagree with an angry person is to remain silent."
—D. Daugherty

Lesson 2
Biology

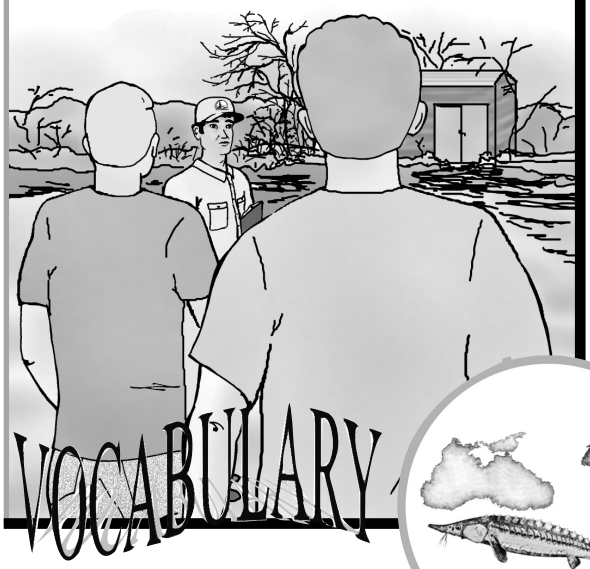
Chapter 5

Features, Spawning, Metamorphosis

Section 1

Lessons 1-5

FISH AND AMPHIBIANS



Ranger Lemon Stewart looked critically at the freshly painted signs drying under the pavilion next to the tool and supply shed. He said, "These may be enough, despite your idleness!

Tom said, "We finished all you requested."

The ranger continued talking as if he had not heard Tom; "Stow your tools in the shed and be certain to lock it." The man looked at his watch and made a mark on his clipboard. "You are to put the signs out on the trail to Rocky Port this afternoon. Tomorrow, you work on Ridge Trail. As you replace the signs, pack in the old ones, because we may be able to salvage them."

After the man walked away, Bryan said, "That means we'll have to spend tomorrow night on the trail."

"If it gets us away from that park ranger and his never-ending checklist, I'm all for it!" Tom declared.

The next morning, the boys enjoyed an especially hearty breakfast that Mrs. Murphy prepared at the lodge. Tom spread what looked like blackberry preserves on his toast. He tasted it and then made a strange face. "What is this?" he asked.

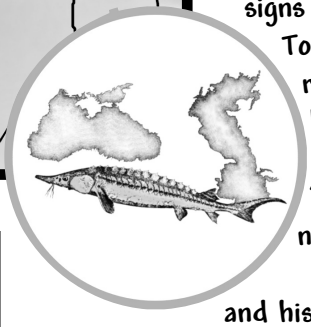
Del responded, "*Caviar*-fish *eggs*."

"Ugh," Tom said and put down the toast.

"Caviar is also known as *roe*. It is considered a food fit for a king," Del said. Then she changed the subject. "Do you realize we have only eight more days until I start back to school. The summer is nearly over!"

Tom ignored the toast with the caviar. He stuffed the last of his scrambled eggs into his mouth. "Our days on the island are numbered, too. You know, Bryan has successfully solved all of the other mysteries. I thought it possible he might discover how your grandfather died and what discovery he had made on the island. But I doubt—."

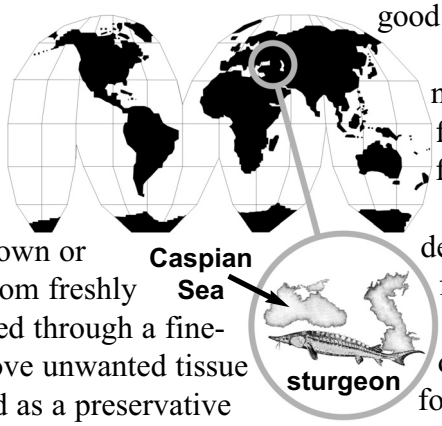
VOCABULARY



Caviar: eggs (roe) of sturgeon, prepared as a food; salmon or bowfin roe may be substituted
Eggs: a roundish reproductive body produced by the female of certain animals, including fish; fish eggs are known as *roe*
Sperm: the male reproductive body of animals, including fish; fish sperm are known as milt
Fry: small, recently hatched fish
Yolk sac: a part of the egg that provides food for the developing fish and for the newly hatched fish
Spawning: the reproductive activity of fish in which female eggs are fertilized with male sperm; fish eggs are fertilized outside the fish's body
Freshwater fish: fish that live in freshwater that is low in salt content, such as rivers streams and lakes

Suddenly, Ranger Stewart burst into the dining room. He looked at the boys with an icy stare. In a cold voice, he directed, "Come with me."

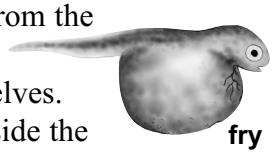
Caviar is the roe, or ***eggs***, of sturgeon that are served as appetizers for elite dining. The eggs, which may be black, red, green, brown or gray, are removed from freshly caught fish and forced through a fine-mesh screen to remove unwanted tissue and fat. Salt is added as a preservative and to improve the flavor. So that it will last longer,
the caviar is pasteurized. Much caviar comes from Russia. Sturgeon prized for caviar live in the Volga River and other rivers flowing into the Black and Caspian seas. Salmon roe from North America are also sometimes sold as a good substitute for caviar.



An interesting note is that Tom had no problem eating the scrambled eggs from a hen, but turned down the eggs from a fish.

In the reproduction of fish, the young develop from eggs produced by the female. The female uses her tail to flip away pebbles and scoop out a depression on the bottom of the stream for eggs. The eggs are laid in the nest, then fertilized by the male's ***sperm***. The eggs are fertilized and develop outside the body of the fish. Although some parent fish protect the developing eggs, others abandon their nests, leaving the small fish to develop on their own.

Newly hatched fish (and frogs) are called ***fry***. Young children are sometimes referred to as "small fries." The small fry fish are still attached to a ***yolk sac*** from the egg. The fry absorb nutrients from the sac until large and skilled enough to fend for themselves. Development of eggs outside the body is risky, because the eggs can be destroyed in many ways. Of the hundreds of eggs produced, only a few mature into fish.



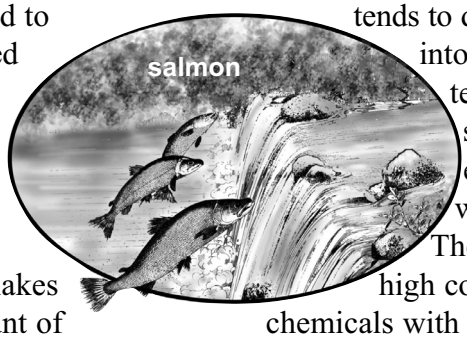
The process of egg laying and fertilization for fish is called ***spawning***. Many species of fish feed in one place and spawn in another. For instance, adult salmon live in the sea. Those in the Pacific Ocean swim hundreds of miles back to where they were "born," up rivers such as the Columbia and Yukon to spawning areas far from the ocean. Traveling about a thousand miles inland, the salmon swim upstream against strong currents, leap over obstacles and jump up small waterfalls. During the spawning season, bears stand in the water and hunt the fish as they come upstream.

VOCABULARY

Saltwater fish: fish that live in saltwater of oceans and inland salt seas that contain saltwater; saltwater fish are also know as marine fish
Urine: liquid waste secreted by the kidneys; urine contains water with waste minerals dissolved in it
Brackish: water that contains more salt than freshwater but less salt than seawater; brackish water is found along the coast where freshwater and seawater mix
Amphibians: cold-blooded, smooth-skinned vertebrates that reproduce in water; offspring have gills but develop air-breathing lungs and live part of their life cycle on land; amphibians include frogs, toads and salamanders
Frogs: amphibians without tails, having strong back legs for leaping and webbed feet for swimming; frogs spend their lives near and in water
Toads: amphibians that are similar to frogs but have rougher, drier skin and are better adapted for life on land
Tadpoles: young frogs or toads; a tadpole has a tail and gills but no legs at first
Metamorphosis: major changes in the physical form of an animal as it grows into an adult; a tadpole undergoes a metamorphosis to become an adult frog

While they travel upstream, the salmon do no eat. Some die on the way or are eaten. Most arrive exhausted and battered from the journey. They die shortly after spawning.

You probably wonder why some fish migrate to spawn. Biologists believe the action is designed to ensure the survival of the species. If fish were to stay in the same location throughout their life cycles, predators would increase by surviving on the large number of fish. By migrating, the predators are denied food while the fish are away. In this way, fewer predators can survive. When the fish return and spawn, their offspring do not face as great of a threat from predators. Because of the huge feast predators enjoy on the adult fish who die after spawning, predators tend to ignore the little, newly-hatched fish. This allows larger numbers of fish to survive.



Fish are described as being ***freshwater fish*** or ***saltwater fish***. Freshwater includes rivers, streams and lakes that do not have a high amount of salt. Saltwater primarily refers to the oceans.

Because fish live in water, they have a special problem in maintaining the proper concentration of water with dissolved salt and minerals. Most vertebrates are designed so that their kidneys filter blood and eliminate excess water and minerals from their bodies. Fish are designed to use not only their kidneys, but also their gills as filters.

The water in rivers, streams and lakes does not have much salt or other minerals dissolved in it. Normally, chemicals tend to equalize their concentrations. The concentration of salt and other minerals is higher in the bodies of freshwater fish than it is in rivers and streams in which the fish live. Water tends to be absorbed into the bodies of freshwater fish to dilute the salt. Minerals that the fish need tend to leave the fish and enter the water. The skin of freshwater fish has a layer of fat to reduce the exchange of chemicals from the water to the fish. However, this barrier cannot entirely eliminate the movement of water by osmosis.

Freshwater fish are designed to eliminate the water that is constantly entering their bodies. Freshwater fish have large kidneys to filter out and eliminate water. Gills are designed to collect minerals the fish needs. Fish ***urine*** is mostly water with a few waste chemicals.

The water in oceans and saltwater seas has a higher percentage of dissolved salt and other minerals than does freshwater. Saltwater fish face the opposite problem as do freshwater fish. In the sea, salt constantly tends to diffuse through the skin and into the body. Water constantly tends to escape from bodies of saltwater fish. Saltwater fish eliminate excess minerals with the kidneys and gills. Therefore, their urine contains a high concentration of waste chemicals with only a little water.

Most freshwater fish are not equipped to live in saltwater, and would die if transported from a river to the ocean. Most fish that live in the ocean would also be unable to survive if dropped into fresh water. A few fish can make the transition. Salmon can make their spawning run from the ocean into freshwater. Freshwater eels migrate, too. Eels are the only known fish that go the other way—from freshwater to saltwater—to spawn. They live in lakes and rivers along the coast of North America. Eels spawn by making a long journey to the Sargasso Sea in the Caribbean. The Sargasso Sea is a region of calm, warm water, characterized by much floating seaweed.

Scientists have not yet been able to determine how eels and salmon make the

transition between salt and fresh water. Apparently, they are designed to spend some time in ***brackish*** water while their bodies adapt to changes in the concentration of salt.

Unique among vertebrates are ***amphibians*** because they lead double lives. The word *amphibian* is from two Greek words meaning "life on both sides." Amphibians are hatched, develop and spend their youth in water. As adults, they live on land. All amphibians are vertebrates. Amphibians include ***frogs***, ***toads*** and salamanders.

The skins of frogs and other amphibians do not provide the same degree of protection as do the skins of other vertebrates. Fish and reptiles have scales. Birds have feathers. Mammals have fur, wool or hair. Amphibian skin has none of these features. Instead, amphibian skin is usually smooth and moist. It has no scales.

Because they dry out so easily, amphibians avoid direct sunlight and are more active at night. Most amphibians spend at least part of their lives in moist surroundings. Their jelly-like eggs are usually laid in water or on the leaves of plants growing in water. Eggs of frogs and toads hatch into ***tadpoles*** that have gills for extracting oxygen from the water. Tadpoles undergo a ***metamorphosis***. Their bodies change as they become adults.

A metamorphosis is not merely a change in external structures. Changes take place in internal organs, too. Tadpoles lose their gills and grow lungs. Their skeletons change as they grow legs, fingers and toes. Adult frogs become capable of reproduction, although they must return to the water to do so. Their diet changes. Tadpoles eat algae and plants. Adult frogs and toads eat insects, earthworms and snails.



The organs of respiration for amphibians include gills, lungs and skin. Frogs, as tadpoles have gills. Adult frogs have lungs, but they are also capable of absorbing oxygen through their thin skins. A frog can be submerged in water for long periods and still survive. Other amphibians also extract oxygen and release carbon dioxide through the skin. This is possible because the skin of frogs is filled with blood vessels that carry gases. Frog skin is not a barrier to the transfer of gases, as in other vertebrates.

Because they have such a complex life cycle, the health of amphibians is a reflection of the condition of the environment. Changes in water, land and air have a profound effect upon amphibians. Scientists have reported an increased number of malformed frogs with three back legs. Some biologists believe such deformed amphibians act as early warning signs that local environments may pose risks to humans.

Ranger Stewart marched the boys to the tool shed. He paused a moment to control his anger, then said, "I came down here this morning to check your work." He quickly spun the dial and opened the lock, then threw open the door to the tool shed. The small gasoline powered electric generator was missing and several of the shelves were empty. Labels on the shelves showed the items that were missing: flashlights, lanterns, rope and repelling equipment.

Ranger Stewart demanded, "Who failed to lock the shed?"

Life Principle



"The frog does not drink up the pond in which he lives."

—Sioux Native American proverb

Lesson 3
Biology

Chapter 5

North to South Pole Zones;
Salamander Types and Characteristics

Section 1

Lessons 1-5

AMPHIBIANS AND CLIMATE ZONES

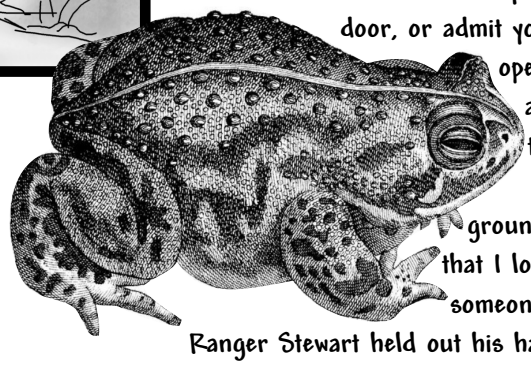


Tom said, "I locked the door. Someone must have broken in!" 1

Ranger Stewart declared, "No one broke in. Neither the lock nor the door has been tampered with. I, alone, know the combination. You forgot to lock the shed. During the night someone carried away the generator and other government property!" 2

Tom tried to explain, "Bryan had gone ahead, and I finished rolling the generator inside, and then I locked the door!" 3

Ranger Stewart was unyielding. "You have two choices. Either admit you forgot to lock the door, or admit you intentionally left it open so you or an accomplice could steal the missing equipment!" 4



Tom stood his ground. "The third choice is that I locked the shed and someone broke in!" 5

Ranger Stewart held out his hand, palm out. "No!" he insisted. "Nothing has been tampered with. I am writing this up and it will go on your record. If you will admit you forgot to lock the door, the incident will look better in my report." 6

Bryan interjected, "If Tom says he locked the door, then he did!"

"Bah!" Ranger Stewart retorted, "You will do well not to defend your friend. If you do, I'll report that you were in it with him!" 7 8

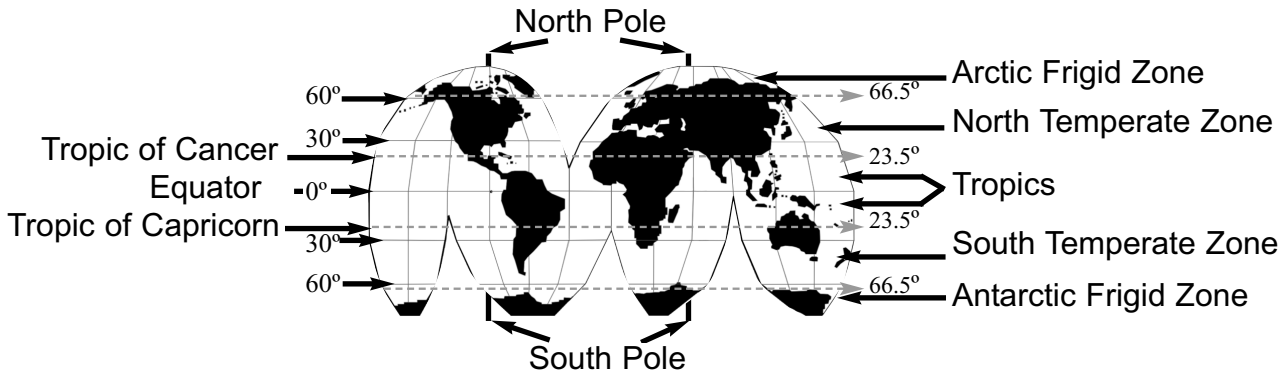
To take their minds off the ranger's accusations, Bryan and Tom busied themselves packing for the trail. Bryan suggested they hike to the end of Ridge Trail and then work their way back, replacing the old marker signs. "That way," Bryan explained, "if we run out of signs, then we'll be closer to the Ranger Station for more. We need to work quickly because the days are growing shorter." 9

Because of its location in the far north, Danger Island

VOCABULARY

Arctic Circle: an imaginary line around the Earth at 66.5º north latitude that separates the temperate region of the Earth from the frigid conditions around the North Pole; the area within the Arctic Circle is also known as the *Arctic Frigid Zone* or *northern polar region*

Frigid Zone: the surface of the Earth that experiences at least one day in which the Sun is not visible above the horizon; is located within the Arctic Circle around the North Pole and within the Antarctic Circle at the South Pole; also called *Polar Climate Zone* or *polar region*



10 experienced pronounced seasons. Days were long in the summer but short in the winter. This variation is caused by the tilt of the Earth on its axis. During summer, the angle of the Sun's rays are more direct. In winter, the rays strike Earth at a glancing angle

The Earth is divided into zones based on the angle of the Sun's rays. North of the ***Arctic Circle*****,** the Sun is not visible above the 11 horizon for one or more days of the year. At the North Pole, the Sun is not visible above the horizon for six months. The zone from the Arctic Circle to the North Pole is the Arctic Zone, or the Arctic ***Frigid Zone***. *Frigid* means "cold." Part of Alaska is in the Frigid Zone. A similar circle, the ***Antarctic Circle*** marks the Antarctic Frigid Zone around the South Pole. Most of the continent of Antarctica lies inside the Antarctic Circle.

The equator of the Earth is an imaginary line that runs around the middle of the Earth at 0º latitude. For several miles on 12 either side of the equator, the Sun's rays are nearly directly overhead, and the weather is hot year around. This region is called the ***tropics***. Another name for the tropics is the ***Torrid Zone***. The word *torrid* means "scorched" or "parched." Hawaii is the only state in the United States that is in the tropics.

The Earth is tilted on its axis. This tilt makes the Sun's position directly overhead at least one day of the year even for people who 13 live several hundred miles north or south of the equator. The northern limit of the tropics is called the ***Tropic of Cancer***. The southern limit is the ***Tropic of Capricorn***. The entire surface of the Earth between these two lines consists of the tropics. Amphibians are found throughout the tropics except in the driest deserts.

VOCABULARY

Antarctic Circle: an imaginary line around the Earth at 66.5° south latitude that separates the temperate region of the Earth from the frigid conditions around the South Pole; the area within the Antarctic Circle is also known as the *South Frigid Zone*

Tropics: the region of the Earth's surface between 23.5° north latitude and 23.5° south latitude; the tropics are also known as the *Tropical Climate Zone* or *Torrid Zone*

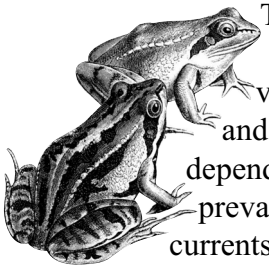
Torrid zone: the surface of the Earth between the Tropic of Capricorn and the Tropic of Cancer; also known as the *tropics* or *Tropical Climate Zone*

Tropic of Cancer: the most northerly latitude at which the Sun can shine directly overhead; the tropic of Cancer is at 23.5° north latitude and separates the tropics from the North Temperate Zone

Tropic of Capricorn: the most southerly latitude at which the Sun can shine directly overhead; the tropic of Capricorn is at 23.5° south latitude and separates the tropics from the South Temperate Zone

Temperate Zones: regions of the Earth with moderate temperatures; also called *Temperate Climate Zones*

The ***temperate zones*** lie between the tropics and the frigid zones. The North
14 Temperate Zone is in the Northern Hemisphere between the Tropic of Cancer and the Arctic Circle. Most of the United States lies in the North Temperate Zone. All of Florida, including Key West, is within the Temperate Zone.

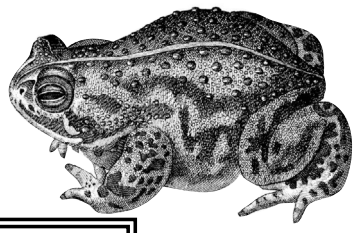


Within the various zones, the weather and climate can vary,
15 depending on such factors as prevailing winds and ocean currents, rainfall and height above sea level. Regardless of their location on Earth, the summits of high mountains often have Arctic climates. Cold water ocean currents cool some islands along the equator. Therefore, despite being in the tropics, the islands have temperate climates.

Amphibians do not have set body temperatures. Instead, their body temperatures vary with the environment. The largest number of species of amphibians lives in the tropics. Amphibians are also found throughout the Temperate Zone. However, amphibians are not designed to survive the cold climates found in the Frigid Zones. Antarctica, the continent at the South Pole, has no amphibians. 16

Frogs and toads are both amphibians. Their early lives in water are similar. As adults they do differ. Frogs have smooth, 17 moist skin, while toads have drier skin and are covered with projections called warts. Toads have shorter hind legs and cannot jump as well as frogs. Toads tend to live in dryer climates than frogs, which are designed for moist humid areas.

Frogs have teeth in their upper jaws only, but toads have no teeth. True frogs have larger 18 back legs, and the spaces between their toes are webbed. True frogs do not venture far from water. The largest frog in North America is the bullfrog. It can grow up to 1.5 feet long and weigh a pound or more. The bullfrog's hind legs are longer than the rest of the body. The hind legs of bullfrogs are menu items in some restaurants.



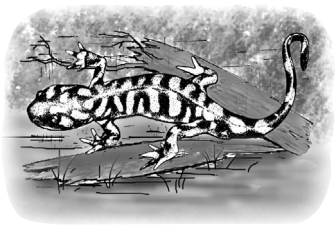
Both toads and frogs have protective coloration. The topside of a frog is colored in shades of green, brown and yellow. When 19 seen from above, frogs blend in with the vegetation that grows in and near ponds. The underside of a frog is a light color. When frogs swim in the water, they appear the same white color as the glare of the sky as seen from below the surface of the water.

Frogs hunt by the sit-and-wait method. They sit still until an unsuspecting insect or other prey comes within snatching distance. 20 A long, sticky, curled-up tongue is attached to the front of the frog's mouth to give

VOCABULARY

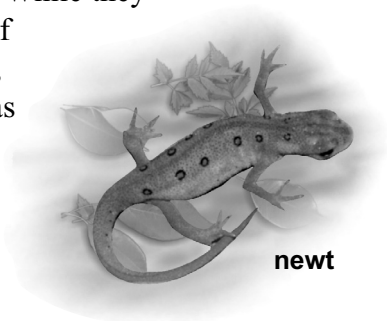
Salamanders: amphibians that resemble lizards, each with a tail and four legs; salamanders have smooth, wet skin that also acts as an organ of respiration
reproduce
Newt: a small salamander that is noted for its colorful body; adult newts live on land in damp surroundings but return to water to reproduce
Mud puppies: species of salamander, found in North America, that has large external gills; so named because they live in muddy areas; were once believed to make barking sounds like those of a dog
Hellbender: a large salamander that is found in the Eastern and Central United States, especially in the Ohio River Valley

greater reach. Like the frog, the toad shoots out a sticky tongue to snare prey that comes close. The extended tongue doubles the length of a frog. The tongue snaps back in so quickly the insect seems to disappear.

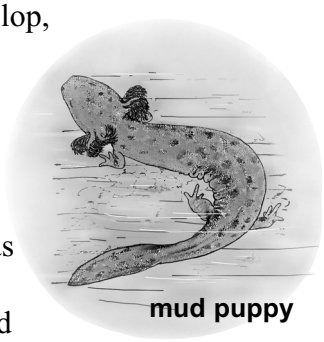

salamander

Only the blink of its eyes as the frog swallows its prey reveals that a catch has been
21 made. Frogs have protruding eyes and always blink when they swallow. Closing their eyelids pushes the eyeballs back into the frog's head. The added pressure forces the food down the frog's throat.

Salamanders are amphibians with short, thick bodies. While they
22 come in a variety of patterns and colors, each salamander has moist skin, four legs and a tail. Salamanders look more like lizards than like frogs or toads. However, like all amphibians, their feet have no claws. Salamanders live in swampy areas and damp, shady areas such as dark woods. During the day, salamanders hide under bark and moss.


newt

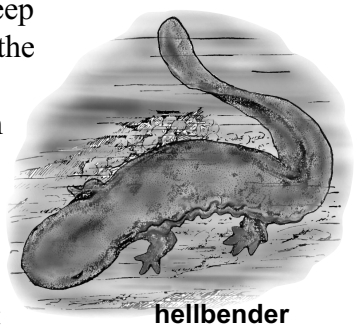
A ***newt*** is a type of salamander.
23 Newly hatched newts have gills and live in water. After they develop, newts leave the water and spend time on land. Adult newts are about three inches long and prefer shaded and damp areas where they feed on earthworms, snails and insects. The skin of newts produces a toxic substance that can kill predators as large as dogs.


mud puppy

After living a couple of years on land, 24
newts return to the water to reproduce. Some stay permanently in the water. Others return to the water once a year to reproduce, usually in the fall. The females produce eggs coated with a sticky substance by which the eggs are attached to plants for protection.

Mud puppies, a species of 25
salamander, spend most of their lives on a river or lake bottom. Salamanders show a great variation in their life cycles. Most have gills when in the water and then grow lungs when they migrate to land. Although lungs develop, mud puppies depend on their gills to extract oxygen from the water throughout their lives. A mud puppy can grow to a length of one foot.

Some adult salamanders that live on 26
land do not have gills or lungs. Instead, they absorb oxygen directly through the skin. The ***hellbender*** is the largest salamander found in the United States and grows to a length of about 2.5 feet. Despite this large size, the creature has no lungs. Instead, the hellbender takes oxygen directly through the skin. The skin has deep wrinkles to increase the surface area that absorbs oxygen from the atmosphere. China and Japan have giant salamanders that grow nearly five feet long. Despite their large size and unusual names, salamanders are generally harmless to humans.


hellbender

Amphibians are important to the 27
ecological cycle. For example, frogs eat insects and serve as a source of food for animals, birds, and fish.

28 The internal design of amphibians is similar to the design of other vertebrates, including mammals. For that reason, frogs are often dissected in biology classrooms to train students to recognize the parts of the skeleton, muscles, digestive system, nervous system, and various body organs.

29 The total number of amphibians has declined steadily since population counts of them began in the 1980s. Most biologists believe a combination of factors have caused the decrease in amphibians. These factors include water pollution and acid rain. Another factor is the loss of wetlands. As farming and urban growth destroy wetlands, amphibians are forced into smaller areas. Amphibians in close contact spread disease, fungus infections and parasites more easily. Because many amphibians breathe through the skin, fungus infections interfere with ability to breathe. A fungus infection can spread quickly from one amphibian to another when they live close together.

30 Tom was perplexed all day long about the break-in. He insisted, "I locked that door! What items did Ranger Stewart say were taken?"

31 Bryan said, "An odd assortment of things were missing: two hard hats with headlights for working after dark, lanterns, flashlights and the electric generator. The rest of the stuff was rope and repelling equipment, like that the rangers use to retrieve hikers who have fallen from cliffs into inaccessible places. Some more expensive items were left behind." Tom asked, "What possible use would anyone have for that equipment?"

32 Bryan had no explanation for the possible use of the stolen property. He continued replacing old signs, which were mostly directional arrows, with new signs.

Life Principle



"Truth is the best response to accusations or questions."

—Anonymous

Lesson 4
Biology

Chapter 5

Features: Cold-bloodedness, Hibernation, Reproduction; Dinosaur Extinction Theories

Section 1

Lessons 1-5

REPTILES



The work of replacing signs along the trails went quickly. Bryan and Tom were only two miles from the ranger station when darkness set in. The boys found a clearing about a hundred feet from the trail and set up camp. There, the boys rolled out their sleeping bags and lay quietly looking at the sky. 1

Tom was restless, but Bryan went to sleep almost as soon as he zipped up his sleeping bag. 2



Hours later, Tom shook Bryan's shoulder, and whispered, "Something woke me up a few minutes ago. I couldn't go back to sleep. I kept thinking about Ranger Stewart accusing me of stealing from the shed. I walked over to the edge of the cliff to look at the ocean and think."

"You don't need my help to think," said Bryan, groggily. 3

Tom persisted, "I want you to see something. Get dressed and come with me!" 4

Bryan put on his outer clothes and hiking shoes. Then he grabbed his binoculars and followed Tom to the edge of the cliff. "What is it?" Bryan asked as they walked. 5

"A boat has pulled up at a little beach," Tom said. "Two men are moving around with flashlights and loading stuff onto the boat!" 6

Fully awake now, Bryan watched the scene with binoculars as the men lifted a heavy load into the boat. "That could be the gas powered electric generator," Bryan said. Just then, the two men started back up the trail. The beams from their flashlights illuminated the path. 7

VOCABULARY

Reptiles: cold-blooded, egg laying vertebrates having a skin covered in scales and breathing by means of lungs; the reptiles are snakes, lizards, turtles, crocodiles and alligators

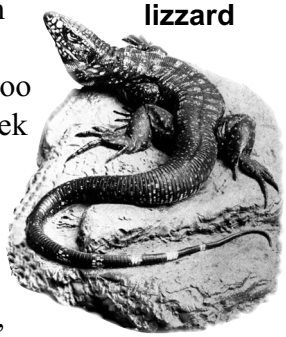
Cold-blooded: refers to any animal that regulates its body temperature by exposing itself to sunlight and shadow; the internal temperature of cold-blooded animals varies with the external environment; all animals except mammals and birds are cold-blooded

8 Bryan was able to get up and out of his sleeping bag immediately. Human beings are warm-blooded. Unlike reptiles, humans maintain a constant body temperature even when asleep.

9 ***Reptiles***, like fish and amphibians, are ***cold-blooded***. A cold-blooded animal has no internal method to keep its body temperature constant. Instead, the temperature varies with the environment. The colder a cold-blooded animal becomes, the slower it moves and the less quickly it can pursue food and escape from danger.

10 The term "cold-blooded" does not mean the animal has a cold body temperature at all times. Although reptiles have no internal organs for maintaining a set body temperature, they are designed to use sunlight and heat of other objects to control body temperatures.

11 On a cool morning, reptiles will position themselves to absorb rays of sunlight. You may have seen turtles sunning themselves on logs floating on a pond. To increase its body temperature, a lizard will sit in sunlight and absorb heat from warm rocks. When the temperature becomes too warm, a reptile will seek shade or hide under a rock. When the temperature is not right for them, reptiles are in constant motion, first darting into the sun to absorb heat, then sprinting into shade to keep from getting too warm.


lizzard

12 Most active reptiles have body temperatures higher than mammals, such as mice. When reptiles are inactive their temperatures match that of the environment.

13 Most reptiles enter a state of ***hibernation*** underground when the weather becomes too cold for them to function above ground. The action of the heart and lungs slow. The reptile falls into a physical condition that appears to be close to death. Hibernation allows reptiles to survive through cold months. When the weather becomes warm, reptiles stir out of their deep sleep, search for food and reproduce.

14 Because reptiles depend on their environment for warmth, they cannot live in regions where the weather is always cold, such as near the Earth's poles. Only in Scandinavia (Norway, Sweden, and Denmark) have live reptiles been found north of the Arctic Circle.

15 Reptiles are abundant in the warmer climates of the southwestern United States and northern Mexico. However, the weather can be too hot for reptiles. They have no sweat glands and cannot cool themselves. In

VOCABULARY

Hibernation: a condition of inactivity that is near death in which biological functions nearly cease; some reptiles hibernate during winter
Torpor: an inactive state similar to hibernation but usually lasting only a few hours or days; cold-blooded animals may go into a state of torpor to survive the extreme heat of mid-day
Aquatic: relating to water; aquatic animals live in, on or around water
Albumin: a water-soluble protein found in egg whites and certain other animal and vegetable tissues
Extinct: no longer existing or living; dinosaurs are thought to be extinct
Fossilized: organic matter in a living organism having been replaced by minerals; turned to stone
Dinosaur: an extinct form of reptile; the word *dinosaur* means "terrible lizard"; some dinosaurs were far larger than any land animal that exists today
Paleontologists: scientists who study past life, especially extinct animals or plants, by their fossils

extremely hot temperatures, reptiles go into a state similar to hibernation. Short-term hibernation for only a few hours such as during the hottest part of the day is known as ***torpor***.

16 Reptiles include snakes, lizards, turtles, crocodiles and alligators. All have scales on their bodies and, except for snakes, have four legs with feet that end in claws. Reptiles breathe air with lungs and reproduce by laying eggs. Although some reptiles are ***aquatic***, they must come to the surface of the water for air and crawl onto the land to lay eggs.

17 Unlike fish and amphibians, reptiles are land creatures. Even ocean-going reptiles such as Leatherback Sea turtles return to the land to lay their eggs. Compare the eggs of reptiles with those of fish and amphibians. Fish and amphibian eggs are soft and have no hard or tough shell, because they do not have to be as well protected. Fish and amphibian embryos grow in the water, which helps maintain an even temperature. Reptile embryos must develop in harsher conditions and without the benefit of being immersed in water.

18 Reptile eggs have a tough skin or a hard shell. The covering is designed to keep the egg from drying out. The developing embryo gets its food from the yolk, while receiving water and other nutrients from the ***albumin***. However, oxygen must come in from the atmosphere, so the shell of a reptile is porous to allow oxygen to be absorbed and carbon dioxide to be expelled.



snake egg

19 Reptiles also differ from fish and amphibians in the way the eggs are fertilized. In the case of fish and amphibians, eggs are laid first and then the male sperm is spread over the eggs. In the case of reptiles, fertilization is internal. The male sperm fertilizes the egg of a female while the egg is inside the female's body. The female then lays the eggs.

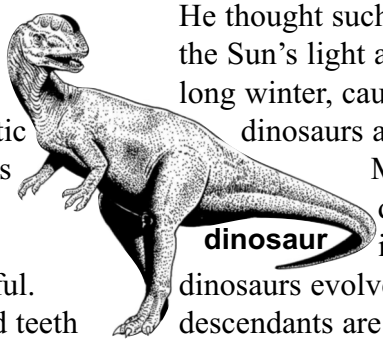
20 Snakes and lizards usually lay their eggs in places that provide natural cover, such as spaces under rocks or hidden openings under fallen trees. Turtles usually bury their eggs in sandy soil. Female crocodiles and alligators make nests for their eggs by wallowing out depressions along the banks of rivers, and then heaping together dead tree limbs, cane and leaves to fill in the holes. Female crocodiles remain near the nests and chase off animals that might eat the eggs. Generally, however, most reptiles abandon their nests once the eggs are laid. No care is provided for the young after they hatch. Rather, they are designed to be able to fend for themselves from the start.

21 In the case of some species of reptiles, the female retains the eggs in her body. The embryos partially develop before the eggs are laid. Some snakes and lizards are designed to give birth to live young. Although the embryo develops in the female's body, all of its nourishment comes from the yolk and albumen inside the eggs. Protecting the eggs in this way allows the developing embryos to survive in harsher or colder conditions.

22 Today, about 5,250 species of living reptiles exist worldwide. However, many reptile species have become ***extinct***. As far back as ancient Greek times, about 250 B.C., Greek philosophers found ***fossilized*** bones that appeared to be from lizards, but were exceptionally large and did not match any living lizard.

23 Scientists did not seriously begin studying fossils until the 1800s. Excavations verify that a large number of giant reptiles once lived on the Earth. In 1841, British scientist Richard Owen coined the name ***dinosaur*** for these ancient reptiles. The word *dinosaur* is from two Greek words meaning "terrible lizard."

24 In most cases, only a few bones of each extinct dinosaur were found. Even a few bones were enough to give scientists an idea of the size and nature of the dinosaur, yet artistic representations included much guess work, because no scientist had ever actually seen a dinosaur. Fossilized dinosaur teeth were especially helpful. Predators usually had sharp, pointed teeth for grasping prey; while grazers had broad, flat teeth for grinding grass. Like lizards today, dinosaurs laid eggs. ***Paleontologists*** have found nests of fossilized eggs along with fossil remains of newly-hatched dinosaurs.



dinosaur

25 At least 1,000 species of dinosaurs are believed to have existed. Each year new dinosaur fossils are found. Although much is known about the dinosaurs, much remains to be discovered. One puzzling question is why dinosaurs became extinct. Some researchers believe a worldwide catastrophe like a flood or the impact of a giant meteorite smashing into the Earth caused dramatic changes which led to the extinction of many creatures.

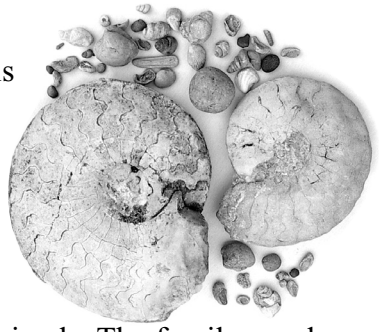
26 The scientist who first proposed that a meteorite collision killed the dinosaurs was Walter Alvarez, a geology professor. While studying in Italy, Alvarez noted a layer of sediment about an inch thick in rock formation thought to be from the "Age of Dinosaurs." The layer, rich in iridium, was also found in several other places around the Earth. The only sources of iridium scientists know of are from meteorites and volcanic eruptions. Alvarez believed the impact of meteorites some 66 million years ago could have thrown clouds of dust high into the atmosphere that could have fallen to Earth, producing the thin layer of sediment that Walter Alvarez discovered.

27 Alvarez theorized that before the dust settled to Earth, a worldwide dust cloud may have obscured the Sun for perhaps months. He thought such a cloud could have blocked the Sun's light and plunged the Earth into a long winter, causing the extinction of dinosaurs and many other species.

28 Many other theories about dinosaur extinction exist, including one that maintains dinosaurs evolved into birds, whose descendants are with us today. Perhaps the most logical question to ask is how other creatures of the past became extinct. the present can be a key to the past. Zoologists point out that extinction in modern times results from imbalances in nature caused by disease, lack of food, genetic problems and over-hunting. Sudden destruction of environments by catastrophes such as fire or flood result in major imbalances.

29 The global flood catastrophe theory is consistent with the fossil record and what scientists know about how fossils are formed. An animal must be buried suddenly in mineral-rich mud to prevent decay or being eaten by other animals. The fossil record shows billions of fossils worldwide, in layers of fossilized sediment, sometimes kilometers thick. The massive numbers of these animals in fossil graveyards, their worldwide distribution and the animals' contorted shapes supply convincing evidence of massive flooding and rapid burial. (Interestingly, the histories of all ancient world cultures record a massive flood that wiped out most of humanity as well as animals.)

fossils



30 Some scientists believe dinosaurs disappeared during a global flood with severe volcanic and meteorite activity. They theorize that meteors heated the oceans to a degree that could have caused massive evaporation followed by massive snows and ice. The severe blizzards over a long time period, could have produced a great Ice Age. Thousands of woolly mammoth carcasses have been discovered, mostly in northern Europe, Siberia and Alaska. Most remains show much decay before freezing, however, some have been found with undigested, tropical vegetation in their stomachs, indicating a rapid freezing. All have been extracted from frozen "muck."

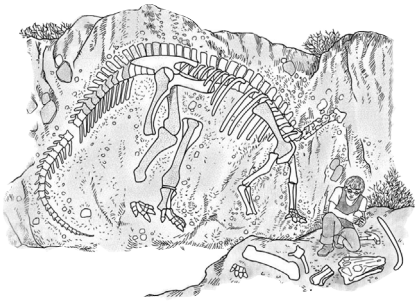
31 Many questions remain to be answered. As new evidence becomes available, old pet theories may need to change. Presently, the science of paleontology requires faith to believe whichever theory one prefers. Scientists do not have all the puzzle pieces on many subjects. Scientists' theories sometimes seem to depend more on their belief systems than on evidence. True science is an ongoing process of applying the scientific method in a quest for truth.

32 "Let's go!" Bryan whispered as he watched the two men start up the trail from their boat. "We can run ahead to see where they are going." The boys jogged down the trail, being mindful of the many fallen limbs and roots that could entangle their feet. They slowed at the point where the side trail from the beach came in. Bryan whispered, "I don't hear or see anything. The men probably are ahead of us."

33 The boys rushed ahead, but almost immediately, Bryan slowed. He whispered, "Look over in the clearing. I can see two flashlight beams!"

34 The glow of the sunrise on the eastern horizon began to illuminate the field. The men turned off the flashlights, but the boys could still see the men as silhouettes. Tom squinted in the half-light, "One of those guys looks like James Olsen, the man who stole my backpack!"

Life Principle



"The present is a key to the past."

—a scientist



Lesson 5
Paleontology

Chapter 5

Importance of Scientific Method in Preventing Hoaxes

Section 1

Lessons 1-5

THE SCIENTIFIC METHOD, FRAUDS AND FAKES



Bryan and Tom hid behind a growth of thick brush. They peered out and strained to see the men walking across the open field. Bryan said, "I wish we had those night vision goggles. We could follow them simply from the heat rays given off by their bodies!"

Suddenly, while in the middle of the field, the two men disappeared. Tom asked, "What happened? One moment they were walking across the field and the next moment they disappeared. Should we try to follow?"

Bryan considered, "No. It is too dangerous. The sun is coming up and we'd be exposed on that open field." As he spoke, one of the men reappeared and began striding across the field toward the boys. The man was tall and walked with an odd gait. Despite the manner of movement, the man covered the ground quickly.

"Let's get out of sight," Bryan whispered. The boys stepped back deeper into the bushes. After the man passed, Bryan said, "He had a large coil of rope hanging from each shoulder. Where is the other person, the one you think is James Olsen?"

The man with the rope was quickly lost to sight as he headed along the trail. The boys followed at a safe distance. Once they were past the cutoff trail to the beach, they rushed ahead to the bluff by their campsite.

The early dawn provided enough light so that the boys could see clearly. They lay down on their stomachs and peered over the edge of the bluff. In the brighter light, they could see that the boat was a small cabin cruiser about 24 feet long. The inboard

VOCABULARY

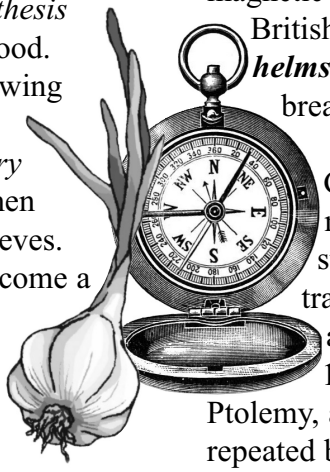
Scientific Method: process of arriving at a scientific theory that includes collecting information by reading and observation, testing the information by experiment, proposing a hypothesis to explain the facts, developing an experiment that will either confirm or reject the hypothesis, and development of a theory that contains the confirmed information and predicts new information not yet discovered.
Pseudo: false or pretended
Helmsman: the person who steers a ship

engines started and the boat puttered away from the rocky shore.

Bryan said, "Let's finish putting up the signs and then tell Ranger Stewart what we saw."

Bryan wanted night vision goggles to watch the two men. In true ***scientific method*** form, Bryan and Tom had a *hypothesis* that the two men were up to no good. The boys busied themselves following clues and making more observations to present their *theory* to Ranger Stewart — that these men were most likely the tool shed thieves.

In order for a theory to become a fact the theory must be submitted to experimental testing to be proved or disproved. True science is a quest for truth and submits ideas to be tested.



VOCABULARY

Preconceived: an opinion that is formed before having adequate facts
Hoax: an elaborate prank intended to deceive but without the intent to gain money; Piltdown Man is generally considered a hoax
Orangutan: a type of large ape
Collagen fibers: protein fibers found in bones, cartilage, tendons and other connective tissues; collagen breaks down and disappears as bones age
Fake: having a false or misleading appearance; an imitation
Duped: easily deceived; unquestioningly serving a questionable cause
Paleontology: the study of forms of past life; often described as the study of fossils
Fraud: a deliberate deception designed to gain money or something else of value; the false *Archaeoraptor liaoningensis* is believed to have begun as a fraud

Pseudo science seeks to force unproven theories upon a population and often ridicules or punishes any attempts to present evidence at variance with the "experts'" opinions. For example, for hundreds of years scientists taught that garlic would cause damage to the magnetic properties of a compass. The British navy took the story seriously. A ***helmsman*** who came on duty with garlic breath was subject to a flogging.

In the late 1500s, William Gilbert read all he could find about magnetism. Rather than accepting a statement as true, he checked it. He traced the statement about garlic affecting magnetism back nearly 1,500 years to a book written by Ptolemy, a Greek astronomer. The story was repeated but never tested in all of that time.

Gilbert chewed on raw garlic until his breath carried a pungent odor. He breathed on the magnetic part of a compass. It held a true north-south course. He even smeared a compass needle with garlic juice. The properties of the compass were not harmed. He muttered, "The whole thing is fable and hearsay."

In 1600, Gilbert published a book, summarizing his 18 years of magnetic research. He reviewed existing information, separated truth from fiction, added knowledge he had uncovered, listed unsolved problems and developed a general theory to explain what he observed.

Gilbert's scientific method had far-reaching effects on scientists such as Galileo, Kepler and Newton, who studied Gilbert's book for its information about magnetism and the method of attacking a scientific problem.

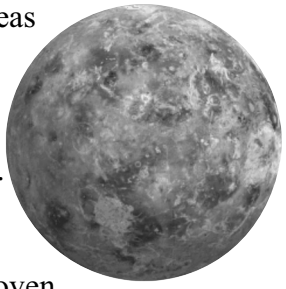
The purpose of the scientific method is to seek truth. Wise students learn to disregard speculations and sensational reports that cannot be proven. Fact, rather than

fiction, is the basis of true science. Each scientific theory or speculation should be treated as fiction until it can be subjected to tests that verify or refute the theory. Not to do so conceals truth, holds back progress and eventually results in embarrassment for the scientific community when the truth finally surfaces.

The changing scientific descriptions of Mercury, the Moon and Venus are examples of the pitfalls of basing theories upon ***preconceived*** notions and fragmentary evidence. Scientific ideas of only a few decades ago have been proven wrong, and spectacularly so.

Scientists thought of Venus as a young, watery Earth with life just getting started. Venus, in that view, might be a planet with dinosaurs sloshing through marshes.

None of these ideas were based on any real evidence, and scientists assumed the planet could never be explored. Some scientists felt free to offer their theories without fear of being proven wrong. As late as 1950, many astronomers described Venus as a watery world with earthlike conditions.



Venus

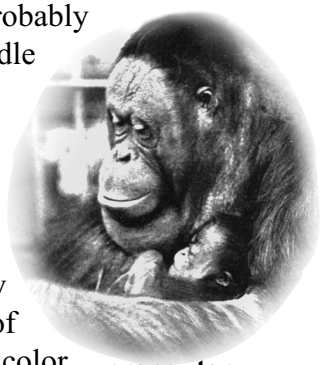
The first evidence to the contrary came in 1956 from microwave radiation. Because of research into microwaves during World War II, scientists could measure radiation given off by a planet. A team of American astronomers concluded that the surface of Venus was surprisingly hot, about 625º F– much hotter than the highest temperature of a household oven. However, most astronomers simply dismissed this report because it did not agree with what scientists believed to be true about the planet. A few years later, space probes showed that the microwave radiation readings were correct. The original ideas about Venus were completely in error. The temperature of the surface of the planet averaged about 858°F—far hotter than first supposed. Mistakes and erroneous theories are part of life. Mistakes can be corrected and theories revised when they are admitted or not taught as fact in the first place.

The Piltdown Man has been called "the man who never was." A supposedly ancient skull and jawbone were discovered in a gravel pit in England in 1912 and declared by the experts to be the "missing link" between humans and their supposed ape ancestors. Scientists accepted the bones as real, without testing them.

The new discovery burst upon the scientific world. Scientific journals and textbooks published models of the Piltdown Man. Museums throughout the world put plaster casts of the Piltdown skull on display. The 1926 edition of the *Encyclopedia Britannica* devoted an entire article to the skull. The British Museum proudly displayed the actual Piltdown skull with the caption "Dawn Man." Scientists came from all over the world to view it.

Yet, the whole thing was a ***hoax.*** Piltdown man never existed. In 1953, Kenneth P. Oakley and a team of researchers at the British Museum discovered the truth by testing the actual bones.

Fluorine dating showed that the top part of the skull had come from a skeleton of a person who had probably died during the Middle Ages. The jaw was that of a young ***orangutan***. Piltdown Man was not old after all.



orangutan

Next, Oakley looked at the color of the bones. The dark color

from iron oxide was only surface deep. Truly old bones would have been stained through and through. The bones still had ***collagen fibers***, easily visible with a microscope. These fibers disappear from ancient bones.

The teeth of Piltdown Man were black, but Oakley discovered that he could scrape away the color. The black substance was paint. Underneath, the teeth still gleamed white. The teeth showed heavy signs of wear. Monkeys eat tender shoots of grass and fruit that do no not wear down their teeth. Humans eat a variety of foods that cause their teeth to wear down. Someone had filed the teeth to make them look human.

The greatest scientists in England had failed to examine carefully the skull and other bones. The ***fake*** bones should have been easily detected by truth-seeking scientists. Seemingly, the hoax had succeeded because the scientists wanted to believe a "missing link" had been discovered that would support Darwin's Theory of Evolution.

Despite the notoriety of the Piltdown man–the man who never was–it was only one of a long list of hoaxes that ***duped*** scientists. Some have occurred more recently.

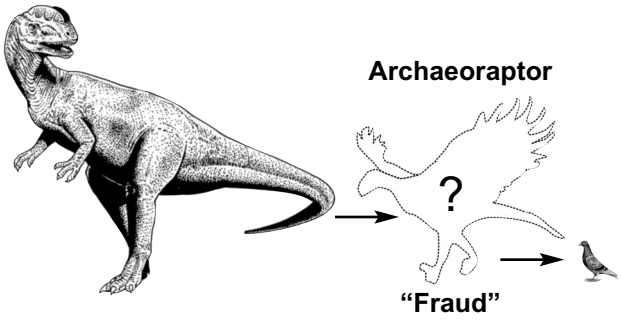
In October 1999, the National Geographic Society, a scientific and educational organization, announced the discovery of an extraordinary fossil.

The November 1999 issue of National Geographic Magazine revealed details of the new fossil. It was believed to be 125 million years old. It contained a birdlike bone structure and a strong, dinosaur-like tail. Experts claimed the fossil proved that dinosaurs had not become extinct, but that some dinosaurs had evolved into birds. The article was illustrated with photographs of the fossil, realistic models and recreations of the fossil as it allegedly appeared in life. The fossil was pronounced a true missing link, or transitional form, that connected dinosaurs to birds. The fossil was named *Archaeoraptor* (meaning "ancient bird of prey") *liaoningensis* (named for Liaoning, the province in China where the fossil had been found).

The majority of bird experts rejected the concept that dinosaurs had changed into birds. Some wisely began to investigate the history of the fossil, which had come from China, yet that country had laws against removing fossils. Fossil hunters had somehow succeeded in smuggling it out of China; and the fossil had made its way to the United States.

Chinese official XU Xing of the Institute of Vertebrate ***Paleontology*** in Beijing, China conducted further investigations. Xu Xing traveled to Liaoning Province, where the fossil had been uncovered. The more he studied the matter, the more suspicious he became of the fossil itself. Early in January 2000 Xu Xing emailed the National Geographic. "I have very bad news," he said. Later he wrote, "Though I do not want to believe it, *Archaeoraptor* appears to be composed of a dinosaur tail and a bird body."

The truth came out. A farmer (an amateur fossil hunter) who found the fossil had



glued the slab of a small fossilized dinosaur tail to the lower portion of the birdlike body, along with bits and pieces of other fossils. The fossil was a ***fraud*** that had sold for $80,000.

By October 2000, the deception became generally known. However, the damage had

been done. The reputation of experts had been marred, and the public had been deceived again by scientists who failed to apply true scientific research.

For three months, a model of the mythical animal was on public display in Explorers Hall at National Geographic headquarters in Washington D.C. About 110,000 people saw the mock-up. Many of them were school children on field trips. The "feathered dinosaur" was featured on television programs and network news. Other museums created displays, claiming that dinosaurs had evolved into birds. Many of these displays have not been removed, despite the fact the original fossil was proven to be a fake.

The news caused scientists to examine other fossils. Paleontologists were dismayed to find that many fossils for sale by fossil hunters had been modified to make them more attractive to buyers.

Scientists must guard against false ideas that capture imaginations and override facts. When scientists fail to do so, they too readily accept fakes and frauds. Moreover, they misrepresent truth.

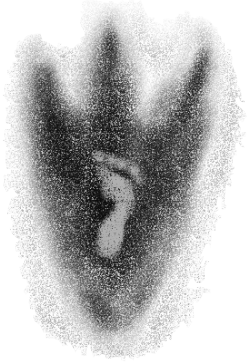
Ranger Stewart listened to the boys story in stony silence. "A likely story!" Ranger Stewart said, "These ghostly men walking at night provide a tidy explanation for the missing equipment. But your tale does not explain how they got into the tool shed."

Del was at the ranger station to pick up the mail. She asked, "What is he talking about?"

Bryan said, "Ranger Stewart thinks Tom is guilty of stealing from the supply shed."

Del protested, "I don't believe that for a minute!"

Life Principle



"Truth will ultimately prevail where there are plans undertaken to bring it to light."

— George Washington

Lesson 6
Biology

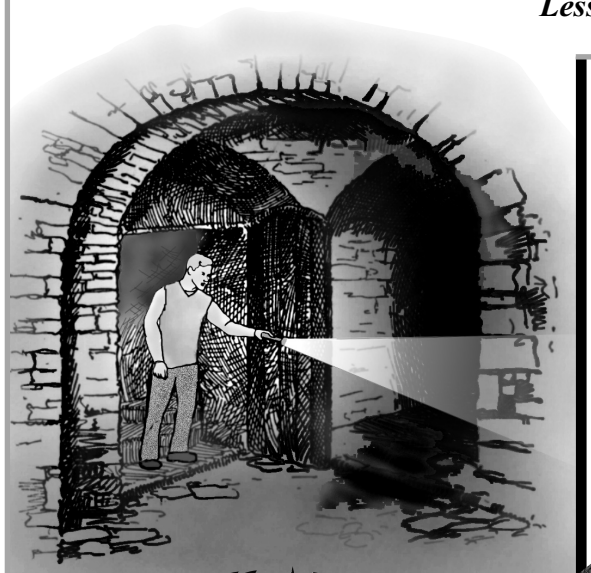
Chapter 5

Vignettes of Darwin and Agassiz;
Venomous and Non-venomous Snakes

Section 2

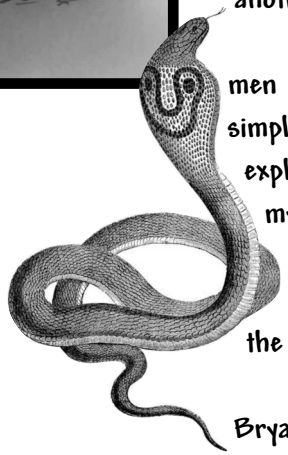
Lessons 6-10

DARWIN, AGASSIZ AND SNAKES



VOCABULARY

Dogma: a statement that is given as absolutely true without the possibility of modification or change
Stethoscope: a scientific instrument used by doctors to listen to the sounds of the body, especially the heart and lungs
Clergyman: a person trained to conduct religious services
Naturalist: a person who studies aspects of the natural world including subjects such as biology and geology
Variations: differences from one animal to another of the same species or litter



Del suggested, "Maybe the thieves took the stuff during the day while the shed was open."

Tom said, "Not a chance. We worked in the nearby pavilion all day. Those two men in the boat could have sneaked up for a minute or two, but they would never have had time to carry away all of that stuff. Besides, the generator was the last piece of equipment that I rolled into the shed, and it was missing the next morning. So we have another mystery!"

Bryan chimed in, "Two mysteries. Those men were in the middle of the field when they simply disappeared. How is that possible?" Bryan explained to Del how the two men so mysteriously vanished while walking across the clearing.

Del asked a few more questions. "I know the place," she said. "It is not far from here."

"So, what are we waiting for?" asked Bryan, "Lets go!" Within minutes, they were at the edge of the field.

Del walked ahead of the boys. She called back over her shoulder,"A large manor house used to be here, but it burned to the ground." Suddenly, she dropped from sight.

Cautiously, Bryan and Tom approached. They found roughly cut stone steps that led down into what looked like an ancient basement. Bryan said, "So, that's how they vanished so suddenly! The stairs down into the bunker are nearly hidden by the overgrowth." Bryan walked down the long flight of stairs and stepped through the dark doorway.

Tom followed, but quickly ran back up the stairs.

"What's wrong?" Bryan called out.

"I saw a snake!" Tom responded.

Del blurted out, "It's just a rat snake, and it has probably already gone into a crack in the wall! It's harmless!"

Del, who usually appeared as a know-it-all, arrogantly proclaimed the snake Tom saw to be a harmless variety, although she had not actually seen it. She was being *dogmatic*, or insisting a thing was true without objectively examining all the evidence or allowing it to influence her thinking.

Science must always test new ideas and adapt to changes. Successful scientists remain open-minded and avoid ***dogma***.

The statement, "Science is the total knowledge of facts and principles that govern out lives" is an example of dogma. It claims that science alone has all of the answers. The statement could be made *non-dogmatic* by changing it to read, "Science is one way of discovering and interpreting facts and principles that govern some aspects of our lives."



In 1930, Werner Heisenberg was awarded the nobel Prize in physics for his discovery of the Uncertainty Principle. Heisenberg's Uncertainty Principle shows that science cannot know everything. Heisenberg revealed that some questions would forever be beyond the reach of ordinary scientific methods. Included would be such things as emotion, artistic imagination and religious faith.

Scientists should measure new data, theories and discoveries against past theories and beliefs when new information casts serious doubt on previously held scientific positions. A truth seeker will muzzle his pride and prejudices when evidence compels a break from outdated scientific beliefs which can no longer be supported dogmatically.

Science includes how information is gained, the way it is summarized and how laws are stated. Scientists use instruments that provide objective data about the world, based on what can be sensed: seen, heard, felt tasted or smelled. Instruments such as the microscope, telescope and ***stethoscope*** *amplify* human senses. Other instruments such as the barometer, clock, scales and ruler *measure* what is sensed. Most scientific laws begin as physical measurements of the subject being studied.

The laws of science must be capable of being proven incorrect. For instance, suppose a scientist claims that outer space aliens landed on Earth a thousand years ago. When asked to produced evidence of this claim, the scientist states that the aliens erased all evidence of their visit. This particular

VOCABULARY

Theory of Evolution: the theory that living things came into being from non-living matter and transitioned into various other life forms over eons of time

Insomnia: a condition of being unable to sleep even when very tired

Tourniquet: a tight bandage that encircles an arm or leg temporarily to stop or slow the flow of blood; prolonged use of a tourniquet can kill tissues that are starved for oxygen normally carried by the blood

theory of a visit by aliens is not scientific because it cannot be proven false or true. To prove a scientific idea false, only one example of its failure is needed. To prove it true, all possible cases must be tried and proven true.

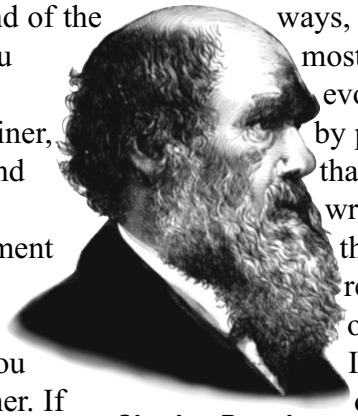
Sometimes two theories explain the same observations equally well. They summarize the same facts and each makes identical predictions about future events. Imagine a sealed plastic container. A friend tells you a steel washer is in the container. Another friend claims the object is a gold coin. The size, weight and sound of the objects are nearly the same. You cannot judge who is correct by measuring the size of the container, listening to the object roll around or weighing the container.

A well-designed experiment lets you eliminate one of the possibilities. In the case of a steel washer and a gold coin, you bring a magnet near the container. If the object is attracted to the magnet, then it is made of steel. If the magnet has no affect upon the object, then it cannot be steel. Suppose the magnet does not attract the object in the container. You disproved the theory that the object is made of steel. However, you have not proven it is gold. The hidden object could be made of silver or some other substance that is not magnetic.

Sometimes scientists view the same data and expound completely opposite theories about the evidence, as in the debate about the origin of the universe and life on planet Earth. The greatest controversy is between evolutionists who believe life and the universe came about by chance, and designists who believe life and the universe were designed by a superior, intelligent being.

If each life form was purposefully designed and created, it happened "in the beginning"—a very long time ago without human witnesses. If life evolved, changing species from lower to higher forms of life over eons of time, it happened too slowly to observe. Therefore, either theory has to be accepted on faith by the believers of those theories. Because neither model can be observed or repeated (two essentials of the scientific method), neither theory can be scientifically tested. Therefore, neither theory can qualify as scientific fact.

If data can be interpreted in two ways, then the way that agrees with the most popular theory (currently evolution) will be most often accepted by persons who disallow the possibility that Charles Darwin could have been wrong in his conclusions. Once a theory becomes commonly accepted, researchers unconsciously interpret observations to fit the theory. Interpretations that disagree with deeply entrenched scientific theories tend to be ignored or ridiculed. Such practice is not true science.



Charles Darwin

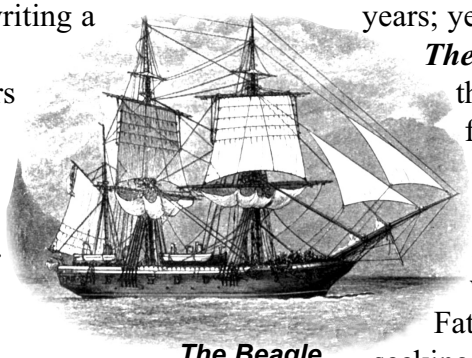
Charles Darwin graduated from Cambridge University in England in 1831, where he had studied to become a ***clergyman***. Darwin's biology professor, also a clergyman, encouraged Darwin to appreciate the wonders of nature. Upon graduation, Darwin craved adventure and set sail on the *H.M.S. Beagle*, posing as a ***naturalist*** in order to secure passage, because all other spots on the passenger list were full.

The ship was bound for the coasts of South America and certain islands of the Pacific Ocean. The voyage lasted four years. During this time, Darwin battled seasickness, read books about the theories of Earth's geologic changes over time, and collected hundreds of animal and mineral specimens wherever the ship anchored. Five weeks were

spent on the Galapagos Islands west of Ecuador observing ***variations*** in certain birds and other creatures.

Darwin returned to England where he began publishing books about biology, geology and his voyage. Through these he became recognized as a scientist, but did not want to work to support himself. In 1839, Darwin married a wealthy cousin who was devoted to Darwin. Together, they had ten children, but Darwin considered his wife and daughters as inferior and incapable of scientific thought.

Darwin continued to write books and review the notes he took while on the *Beagle*. In 1844, he secretly began writing a book about the concept of evolution. About fifteen years passed, but still he did not have enough evidence to publish his theory. Then, Darwin discovered Alfred R. Wallace had developed a theory of evolution and was about to publish it. Not to be outdone, Darwin decided to go public. In 1859, he published his *Origin of Species*.



The Beagle

It produced an immediate uproar. Within ten years, a flood of highly educated people had embraced Darwin's theories for a variety of reasons. In the following years, this development spawned a tidal wave of philosophies based on evolution, including humanism, atheism and socialism. Soon after *Origin of Species* was published, hundreds of prominent scientists worldwide fiercely opposed the concept of evolution, including 720 who made their views known by signing the famous *Scientists Declaration of 1864* in which they affirmed the accuracy of the Bible regarding scientific matters. A similar proclamation entitled *A Scientific Dissent from Darwinism,* signed by over 140 scientists of high reputation was recently published. This was done to refute the claim that "all reputable scientists support evolution " as the explanation for the existence of life on Earth.

In his book, Darwin expressed concern that the fossil record did not support his theory about various life forms becoming other forms. Surely, if over millions of years cows became whales, apes became humans and reptiles became birds, millions of transitional forms of many creatures should be evident. However, there were no true transitional forms.

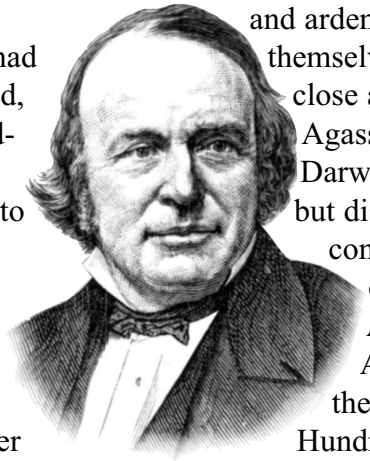
Darwin was confident that many such fossils would be discovered in the following years; yet over 140 years later the ***Theory of Evolution*** remains a theory without transitional fossil support. Despite his lack of training in the life sciences and the lack of evidence for his theories, Charles Darwin was catapulted to fame as the Father of Evolution by persons seeking an alternative "scientific" belief system.

Darwin suffered recurring bouts of a mysterious ailment that baffled doctors and produced vomiting, **insomnia**, trembling and rapid heart rate. Some scientists believe his illness was caused by the inner conflict of leading a double life, because he was most sickly when he worked on matters of evolution. From his studies to become a clergyman, Darwin knew the Bible taught that man and each animal type was created to reproduce after its own kind, not to transition into other life forms. Darwin's wife, along with his friend and biology professor, John Henslow, and others whose company he valued, were staunch Christians who believed the world had been made by a superior Creator. Darwin knew his ideas hurt his family and friends. When he worked on other

matters, he enjoyed better health.

Many scientists point to Louis Agassiz, the Swiss-American naturalist (biologist) as one of the great figures of scientific discovery. Louis Agassiz (1807-1873) lived at about the same time as Charles Darwin (1809-1882.)

Louis believed the Earth had been intentionally created. He said, "Creation isn't a jumble of mixed-up pieces. They fit together in a pattern. The job of a naturalist is to trace out that pattern."



Louis Agassiz

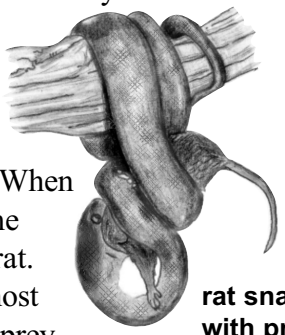
Agassiz was the first to propose the concept of a great Ice Age to the scientific community. He showed that glaciers were rivers of ice left over from the Ice Age, and proved by experiments that they move slowly. He was America's first geologist and is recognized as the Father of Glaciology, or glacial geology.

Swiss-born Louis Agassiz visited the United States in 1846 for a lecture tour on natural history. He called his lectures "Plan of Creation," and over-capacity crowds flocked to hear him. Agassiz temporarily settled in Boston and was appointed professor of zoology at Harvard University. Later, Louis moved permanently to the United States and became a citizen.

Louis Agassiz is considered one of the greatest teachers of science who ever lived. During his years in the United States, almost every naturalist in America had either been one of his students or studied under someone Agassiz had taught. Because he was one of the best informed and most capable biologists of his day, his expert opinion was respected among scientists. Agassiz was also a paleontologist, and he had an earned medical degree.

Unlike Charles Darwin, Louis Agassiz believed women did have the mind for scientific studies, so he offered courses for women. Agassiz felt great sadness that some of his students embraced Darwin's proposal, and said, "I regret that the young and ardent spirits of our day give themselves to speculation rather than to close and accurate investigations." Agassiz retraced some of the places Darwin had visited aboard the *Beagle*, but disagreed with Darwin's conclusions. Louis called the idea of evolution a "desolate theory." Agassiz was the most prominent American biologist to oppose the theory of evolution in the 1800s. Hundreds of great scientists in Europe also believed in the purposeful design of life rather than evolution, including Louis Pasteur, William Thomson (also known as Lord Kelvin) James Joule, Gregory Mendel, Richard Owen and Joseph Clerk Maxwell.

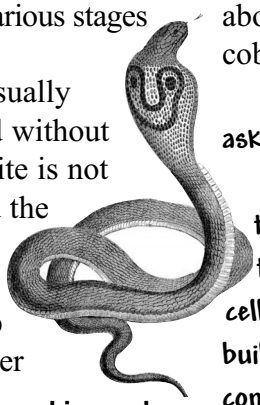
Biologists and zoologists, like Agassiz, study all animal forms, including snakes and other reptiles. Most snakes found in the United States are not venomous, and many are beneficial. For example, the rat snake lives in and around barns or old buildings and kills rodents by constriction. The snake wraps its body around a victim and squeezes until the prey cannot breathe. When it stops struggling, the snake swallows the rat. The rat snake, like most snakes, can swallow prey larger than the snake's mouth. Its jaw can be unhinged. Sharp, needle-like teeth pointed toward the rear of the mouth help convey the prey along. A rat snake often has bulges along



rat snake with prey

its body. These are probably rats and mice the snake has swallowed and are in various stages of digestion.

Non-venomous snakes usually bite humans only when cornered without a way of escape. Although the bite is not poisonous, it can be painful, and the broken skin can offer a site for bacteria to start an infection. A bite should be cleaned with soap and water and treated as any other puncture wound.



king cobra

Only about 15 people in the United States die as the result of poisonous snakebites each year. This is far less than deaths caused by bee stings or diseases carried by mosquitoes.

The best snakebite prevention is to avoid opportunity for a snakebite. Do not put your hands or feet into areas you cannot see.

Quick action should follow a poisonous snakebite. Experts now caution against cutting the wound to drain or suck out the toxin, or using a tight ***tourniquet*** to stop the spread of the venom. These measures could cause more problems than they help.

The best action is to keep the bitten limb in a horizontal position and wrap a bandage firmly all the way around the bite area as a light tourniquet. The victim should stay calm, avoid strenuous activity and should not drink caffeinated beverages. Caffeine or excessive movement increases the pulse rate and circulation of the blood carrying the venom; caffeine also uses up oxygen in the blood. Oxygen is already in reduced supply due to the effects of venom from copperheads, moccasins or rattlesnakes. Medical treatment within one hour of the bite is recommended.

The 18 foot long king cobra is the largest venomous snake in the world. Its venom, similar to that of the small coral snake, attacks the nervous system, killing about one person in 10 who is bitten by a cobra.

As Tom descended the stone steps he asked, "Why did the two men come here?"

Del stood in the gloom at the bottom of the rough stairs and gave a brief history to the boys: "The manor house had a large cellar and many storage rooms. My grandfather built his workshop in one of the rooms. He had come here to work one day and was never seen again. All anyone found was a box wrapped as a present for my mother. The cracked souvenir plate was in the box"

The boys picked their way through the dimness to join Del. By now, she was standing at the end of a long stone corridor with a high, vaulted ceiling. Bryan offered, "Mr. Murphy's wood working shop might have a clue as to what happened to him." Bryan switched on his flashlight and the trio entered the gloomy, underground bunker.

Life Principle



"Most of our arrogance ...is due to our ignorance"

— Nicholas Copernicus

Lesson 7
Biology

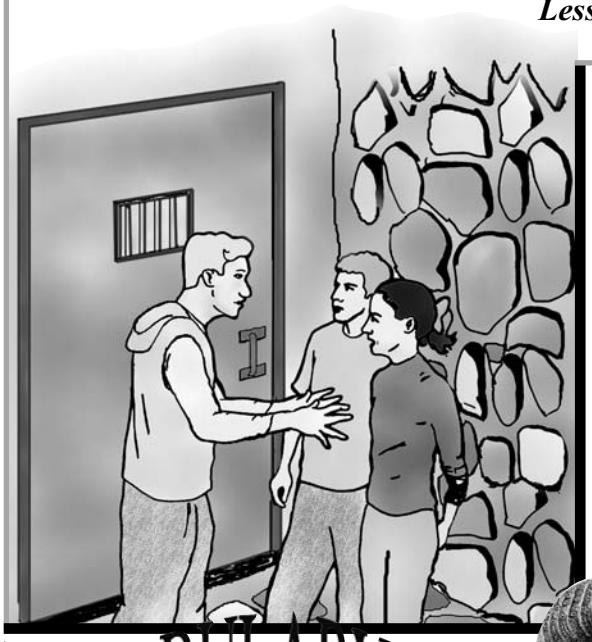
Chapter 5

Characteristics and Habitats of Various Types

Section 2

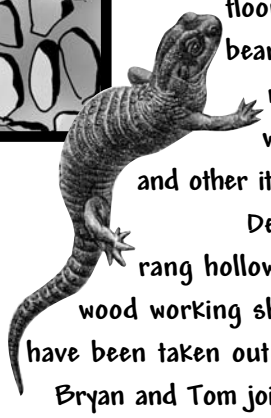
Lessons 6-10

LIZARDS AND TURTLES



Bryan, Tom and Del cautiously walked along a stone corridor with a high ceiling. The corridor opened into a number of rooms. Most had massive wooden doors four inches thick. Except for a small, narrow window at the ceiling level in the wall opposite the door, each room was as solid as a vault.

A century of grime and dirt covered the stone floor. In one of the rooms, the debris on the floor looked disturbed. Bryan played the beam of the flashlight over two parallel skid marks. He theorized, "This is probably where the thieves stashed the generator and other items before they hauled them to the boat."



Del had gone on down the hall. Her voice rang hollow as she called, "Here's my grandfather's wood working shop. All of his drills, lathes and tools have been taken out."

Bryan and Tom joined her. The light from the tiny window revealed dusty shelves along the wall and several heavy tables and benches. Tom poked around in the trash bin at the back. He pulled out a badly damaged wooden model. Tom said, "Before it was crushed, it looks like this was a doll house in perfect miniature detail."

Del said, "It must have been the gift that my grandfather intended for my mother." She took the broken model from Tom and gently put it on one of the shelves.

The rattle of dry leaves sounded from the corridor. "What was that?" Tom whispered.

Del said, "Probably that rat snake you saw, or maybe a lizard."

Lizards, like all reptiles, have dry, scaly skin. Most lizards are small and have four legs with feet that end in

VOCABULARY

Lizards: reptiles with elongated bodies; each with scales, eyelids, a long tapering tail, four legs, and feet that end in claws
Glass lizard: a lizard with scales that are shiny like glass; sometimes called a glass snake because it does not have legs; the tail can break off and re-grow
Horned lizard: a squat lizard with spiny projections on its body, horn-like projections on its head and a short tail; also called a "horned toad"
Carrion: dead and decaying flesh, an animal that eats carrion is known as a *scavenger*

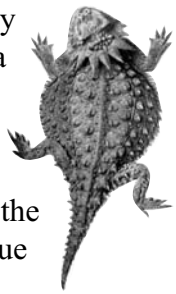
claws. Because of their claws, lizards can climb and dig easily. They have slender bodies and long tails that in many species break off easily but will regenerate, or re-grow. Unlike snakes, most lizards have external ears and movable eyelids. Lizards cannot separate their upper and lower jaws the way snakes do to swallow large meals.



glass lizard

Most lizards have four legs. One exception is the ***glass lizard***, so named for its smooth scales that shine with a glass-like luster. The glass lizard is sometimes called the "glass snake" because it has no legs. However, it has eyelids, external ear openings, and cannot unhinge its jaws to eat a big meal whole. Biologists use these features to class the glass lizard among lizards rather than snakes.

Lizards have sharp teeth for grasping prey. Smaller lizards eat insects. The ***horned lizard*** lives in the deserts of the United States. This lizard has a roundish body covered with rough protrusions, and a short tail. Although a lizard, it is sometimes called a "horned toad." It often stations itself near an anthill because ants are its favorite food. As the ants crawl by, the lizard's sticky tongue laps up the ants.



horned lizard

Larger lizards eat birds, snakes, eggs of both birds and reptiles, and small mammals. Some predators will eat only animals which the predators themselves kill. Lizards are not as particular. They will eat ***carrion***, the remains of animals that have died or been killed by other animals.

Lizards, like all reptiles, are cold blooded. Both are common in the tropics and in warm temperate climates, because heat helps reptiles maintain proper body temperature. Extremely dry heat, however, presents a problem, because it dries out reptiles' bodies and their eggs. To compensate, the scales of reptiles are designed to off-set excessive heat by acting as a barrier to prevent water loss by evaporation. Lizard eggs are covered with a tough, ***parchment***-like skin that is also geared to prevent water loss. A lizard egg has a surface that feels like leathery paper.

Lizard eggs can withstand harsh conditions. In the tropics, sudden rain showers can wash mats of vegetation into the sea. Lizard eggs laid on the vegetation can survive the sea journey until currents carry their natural raft to an island. There the eggs hatch. With few natural predators, the lizards can eventually become the dominant life.

VOCABULARY

Parchment: a writing surface made from the skin of a sheep or goat; parchment is dry and leathery; some reptile eggs have a shell that feels like parchment

Excrete: to discharge waste matter

Iguana: a large lizard that lives in the tropics, having green skin and spiny projections along its back; unlike most lizards iguanas are vegetarians, eating only plants; iguanas are kept as pets and eaten by humans

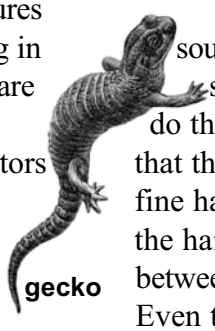
Gecko: small, harmless lizard that makes a "gecko" sound and has the ability to climb smooth vertical surfaces and walk upside down across ceilings

Gila (he-la) monsters: venomous lizards that live in desert regions of the southwestern United States and western Mexico; scales give a colorful bead-work appearance; the Gila monster is named after the Gila River that flows into the Colorado River at Yuma, Arizona

Chameleon: a lizard that can change its color, usually to match its surroundings and become less visible to predators

Lizards that live in deserts often can survive without drinking water. They extract moisture from leaves and the small insects or animals eaten. Digesting food and burning it for energy generates water as a by-product. Lizards are designed to conserve water when ridding their bodies of waste products. The urine of lizards is concentrated, because waste chemicals are eliminated with a minimum of water. Many lizards have glands designed to ***excrete*** salt and other minerals.

Lizards cannot survive prolonged cold weather, and none are found in either Arctic or Antarctic Frigid Zones. Because of their need for warmth, lizards are most active during the day. Lizards must warm to 80ºF before they can begin the day's activities. On a cold morning lizards will align themselves with the sunlight and lay against a rock or tree trunk that is also absorbing sunlight. Lizards are designed readily to absorb radiant heat from the sun and thereby raise body temperatures high enough to move about despite being in cool air. When warm and active, lizards are nimble and dart about quickly.


gecko

Although most lizards are predators of insects and small animals, lizards themselves are the prey of a variety of other animals including birds, coyotes, and snakes. Different species of lizards have unusual designs for protection and defense. Some lizards can puff up. They hide in rocky crevices and inflate themselves with air. Pulling them out is nearly impossible once they wedge themselves in their hiding places. Some lizards can run quickly. One member of the ***iguana*** family can reach a speed of 15 miles an hour. It runs on its two back feet and splats them down so quickly it can race across the surface of water.

Iguanas are large lizards found from Mexico to the rain forests of Brazil. Most iguanas are green with brown bands. They reach a maximum length of about six feet. Unlike other lizards, iguanas are vegetarians. They eat fruit and tender vegetation. Iguanas are clean and require little attention when kept in homes as pets.

About half of the length of most lizards is the tail. Many lizards have an effective defense by giving up their tails. If a predator such as a bird grabs one of these lizards by the tail, it comes off and flops and twitches on the ground. The bird is distracted while it tries to subdue the wiggling tail. Silently, the lizard makes its escape and re-grows its tail.

The gecko is such a lizard. The ***gecko*** is a small lizard that is found in very warm areas. Other lizards can make only a hissing sound. The gecko is a noisy little lizard. It is named after the sound it makes—a dry clicking "gecko" sound. This lizard has adapted to humans and sometimes can live in their homes.

The wonder of the gecko is not the sound it makes, but its ability to climb smooth, vertical walls. How it is able to do this is still a mystery. Scientists know that the gecko's feet pads have millions of fine hair-like projections. Scientists believe the hairs are so thin that they penetrate between the molecules of smooth surfaces. Even the smoothest glass is no challenge for the gecko. It can climb the side of a smooth window and run upside down across a featureless ceiling.

Only a couple of species of lizards are venomous. ***Gila monsters*** live in the deserts of the southwestern United States. The body of a Gila monster is covered with pinkish orange and black bead-like scales, and can reach a length of about two feet. The teeth that release venom, unlike snakes, are at the back of the mouth and are not hollow. Instead, the teeth


gila monster

have a grooved track through which to dispense venom. The Gila monster clamps onto its prey and chews to release the venom. The Gila monster is not a particularly fast lizard and seldom poses a threat to humans.

The ***chameleon*** is well known for its ability to change colors. Cells at the surface of the skin have ***pigment*** granules with colors such as green, yellow or brown. The cell takes on the color of the granules when they are clustered together. The cell loses the color if the granules are dispersed throughout the cell. When the chameleon is frightened, it releases ***hormones*** that cause the color change.

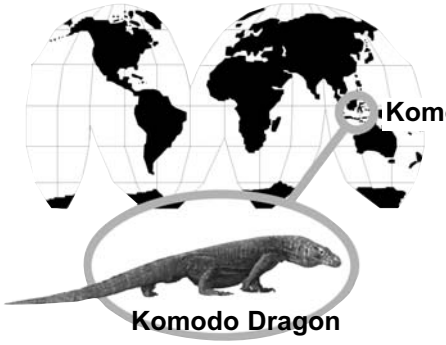


chameleon

Many people believe the chameleon changes its color to match its surroundings. The new color is likely to make the chameleon less visible and more nearly the same color as the surrounding background.

The chameleon lives in trees. Its toes are made for encircling small limbs. Two of its long, thin toes go on one side of the branch and the other three go on the opposite side. The chameleon has a strong tail that can also grasp branches. Some chameleons have bulging eyes that operate independently of one another. One eye can look forward while the other swivels around to look toward the back. A chameleon has a long, sticky tongue that rapidly unfurls to catch insects.

The largest lizard presently in existence is the ***Komodo Dragon***. It lives on the Komodo Islands and nearby islands in Indonesia. The Komodo Dragon can reach a length of 10 feet and a weight of more than 300 pounds. The lizard has strong legs and a powerful tail. The Komodo is good at digging and tunnels out a burrow 25 feet deep. The lizard's tongue is long and forked like that of a snake. The Komodo Dragon feeds on the same type of food as most other lizards, but its large size means it can target larger prey. A fierce fighter, it can kill larger animals.



Lizards have little economic benefit one way or another to human beings. They do help control the population of insects. Lizard diseases that can be contracted by humans are few, and most lizards are not venomous. Iguanas and chameleons are kept as pets. At one time, lizards were hunted for their skins. Today, however, laws protecting lizards, ***curtail*** the trade in lizard skins.

A ***turtle*** is a reptile that carries its shell-home on its back. A turtle can withdraw

VOCABULARY

Pigment: a substance that produces color in plant or animal tissue
Granules: small grains, pellets or particles
Hormones: chemical messengers produced by one organ and sent by the bloodstream to another organ to change its activity; hormones trigger the color change in a chameleon's skin
Komodo Dragon: the largest species of lizard, reaching a length of 10 feet and weighing more than 300 pounds; a type of monitor lizard, it is an endangered species
Curtail: to shorten or reduce
Turtle: a toothless reptile that has a sharp, horny jaw and a shell into which its head, legs and tail can withdraw
Integral: a single unit that cannot be separated
Fused: melted or blended together

its head, four legs and tail into the shell for protection. The legs, neck and tail are covered with scales like those of other reptiles. The shell is an ***integral*** part of the turtle and is made of horny plates. The vertebrae and ribs are ***fused*** to the shell. Removing the shell of a turtle kills the animal as certainly as removing a human's backbone would kill a person.

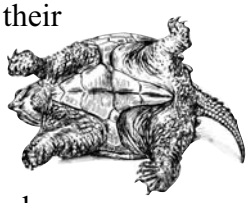
Turtles have no teeth. Instead, the edges of their jaws are lined with sharp plates. The jaw is powerful, and a snapping turtle is capable of taking off a human's finger. The shell on the underside of a snapping turtle does not entirely cover its body, so the snapper is especially aggressive in protecting itself. Its jaws are large and sharp, and the turtle does not hesitate to use them.

The largest turtle found in freshwater rivers and streams is the alligator snapping turtle. A fully-grown adult may weigh as much as 200 pounds. This snapper has an interesting way of enticing prey into its mouth: it has a soft projection on the floor of its mouth that looks like a worm. The turtle holds its mouth open and wiggles the phony worm to lure small fish into the trap.

Sea-going leatherbacks are the largest of all turtles. They can attain a length of eight feet and weigh a half of a ton (1,000 pounds). Their legs are shaped like flippers, which enable leatherbacks to swim with ease. Female leatherbacks and other sea turtles migrate long distances to lay their eggs on land. The turtles crawl above the high tide line and bury their eggs in the sand.

snapping turtle





snapping turtle (under side)

The female is very particular about the nest. She finds a place that will be exposed to sunlight for incubating the eggs. Using all four of her legs, she digs a depression in the sand. Then she uses her hind legs to make an even deeper pit. She does not begin laying eggs until the nest is dug to her satisfaction. If one of her back legs has been injured and she digs a misshapen nest, she will keep shaping it until it is correctly constructed. After laying the eggs, she restores the site to its natural appearance.

Bryan said, "Maybe we should see what else is in that trash barrel."

Suddenly, the door slammed shut with a thud. Bryan turned and ran to the door. He heard a lock click into place outside. The door had a small opening in it with four metal bars. Through the opening, Bryan saw Tom's worst nightmare —James Olsen!

James Olsen turned out to be much older than he had originally appeared. Olsen was at least in his 40s. However, he seemed unsure of himself. He jumped nervously from one foot to the other. "Listen, I'm sorry about this. My partner is a hard case. He threatened me. He told me to do what he said or he would break every bone in my body!"

LIFE PRINCIPLE



"You can lead an animal to water, but you can't make it drink."

—Anonymous

Lesson 8
Biology

Chapter 5

Types, Characteristics, Habitats

Section 2

Lessons 6-10

TURTLES AND CROCODILES



The man on the other side of the door wore blue overalls. He was a small person, round-faced and pudgy. He spoke with a soft, syrupy voice. James Olsen said, "My partner saw you following us last night but pretended not to notice. He figured you would come back to the bunker. He told me to wait for you and—" 1

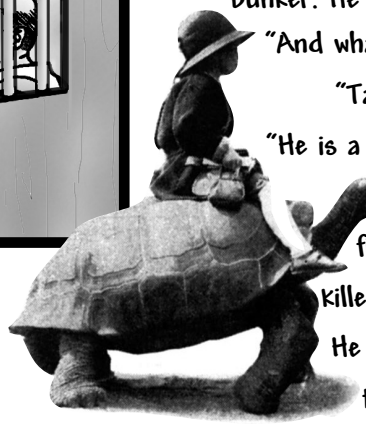
"And what?" Bryan demanded. 2

"Take care of you," James Olsen said. "He is a really scary guy. Years ago, he worked in the area as a fisherman on a trawler. Then he killed a man and hid out on the island. He learned about Mr. Murphy's treasure. He kidnapped Mr. Murphy, but their boat sank during a storm. My partner survived, but he was sent to prison for the earlier murder. Shortly before his sentence was up, he contacted me to look for the treasure. He got out of prison a couple of weeks ago and came here. Olsen paused, then said, look, I'll figure out some way to let your family know that you are locked in the bunker. They'll come and get you out." He turned and ran away from the door. 3

"Wait! Don't leave us locked in here!" Tom cried. 4

Bryan, Tom and Del kicked at the door. It did not budge. Del opened her backpack purse and got out a small mirror. She put her hands through the bars and reflected the latch in the mirror. 5

Bryan said, "There's a padlock on the latch. We are not going to get out that way!" 6



VOCABULARY

Trawler: a fishing ship that pulls nets or lines with hooks
Urbanization: to change a region from a natural or rural area into one with city-like characteristics
Box turtle: any of several species of North American land turtles with a dome-shaped shell; top and bottom parts of the shell are hinged and can close to completely encase the turtle

7 James Olsen's partner worked on a ***trawler***, a fishing ship that pulls nets or lines with hooks to catch fish or other sea life such as shrimp. One problem with the fishing nets of trawlers is that they ensnare turtles. Loggerhead sea turtles are prone to being caught in shrimp trawler nets. Like all reptiles, turtles must come to the surface for air. When trapped in nets, turtles cannot rise to the surface and they drown. Scientists developed a wire mesh *turtle excluder* device that prevents turtles from being caught, thereby saving lives of thousands of turtles each year.

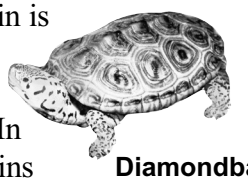
8 Most sea turtles are in danger of extinction. In addition to being accidentally killed by fishing boats, turtles face danger on land. Their meat and eggs are prized as food in some coastal countries. Turtles come ashore at night to lay their eggs, but hunters often capture the turtles and take their eggs. In some tropical nations, turtles are harvested for their shells. The shells can be polished and fashioned into decorative jewelry and hair combs.

9 Another reason for the decline in sea turtles is human development along shorelines. Turtles on land face a threat from increased ***urbanization***. Destruction of habitats has reduced turtle populations. Highway construction between nesting grounds and the ocean has hampered turtles from moving from where they feed to their nesting grounds. A heavily traveled highway can be a formidable obstacle to slow moving turtles. The top speed of land turtles is only about one-third of a mile per hour, or about 30 feet a minute.

10 The numbers of many species of land turtles are declining, including the common ***box turtle***. Box turtles are North American land turtles that measure about six inches long. In warm weather, they feed on earthworms, insects, berries and mushrooms. On hot summer days, they crawl into creeks to cool. In winter, they dig into soft soil and hibernate below ground. Box turtles are often kept as pets. So many have been captured and sold overseas as pets that the species is considered endangered.

11 The meanings of the names *turtle* and ***tortoise*** vary by region and country. The British, for instance, use the word *turtle* for sea-going species of turtles. They use the name *tortoise* for land turtles. In the United States, the name *tortoise* is applied only to those land turtles that have a dome-shaped shell.

12 The name ***terrapin*** is applied to turtles of a certain biological family. In the United States, the best known terrapin is the diamondback terrapin. It lives in freshwater and has a diamond design on its shell. In the past, diamondback terrapins were hunted to near extinction because their meat was considered a ***delicacy***. Today, diamondback terrapins are a protected species.



Diamondback terrapin

VOCABULARY

Tortoise: the name applied in the United States to any land turtle with a dome- shaped shell

Terrapin: the name applied in the United States to a turtle with a diamondback design on its shell that is good to eat

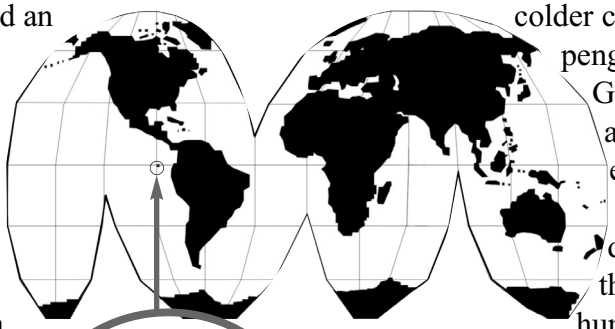
Delicacy: a pleasing and appealing food; a delicacy is rare, in short supply or otherwise difficult to obtain and usually expensive

Crocodiles: reptiles that live in the tropics and warmer temperate climates; a crocodile has tough, armor-like scales, a powerful jaw and tail and feet that end in claws; crocodiles are flesh eaters who live in and around water

Carnivores: animals that eat flesh

Wildebeest: a large African antelope with a long drooping mane and thick curved horns; also known as a gnu (new)

13 In the United States, a tortoise (land turtle with a domed shell) can close its shell very tightly. Once the tortoise pulls in its head, legs and tail, the hinged top and bottom shells close completely. The two parts fit together so tightly a knife blade will not fit between the parts. Its thick shell and heavily scaled limbs protect a tortoise against most enemies. Because it can withstand an attack so readily, a tortoise has a gentle disposition. It is patient and will withdraw inside its shell and wait until whatever is disturbing it leaves. However, a turtle is at a distinct disadvantage when it lands on its back. It has no way to right itself. It must depend on another creature or event to be turned right side up. Without assistance, the turtle will die due to starvation or weather conditions.



Galápagos turtle

14 Turtles have a reputation for a long life, but proving how long they live is difficult. The normal life span for box turtles kept in zoos is about 40 years. Those in the wild may live longer. The largest turtles, weighing up to 600 pounds and believed to live the longest, are the giant turtles (tortoises) of the Galápagos Islands. These turtles are believed to outlive all other vertebrates, including humans. Some people claim that the slow moving, gentle Galápagos turtles live more than 150 years.

15 The Galápagos Islands are a group of 13 larger islands and many smaller ones in the Pacific Ocean, about 650 miles west of the coast of Ecuador in South America. The Spanish discovered the islands in 1535 and found thousands of giant turtles, each weighing hundreds of pounds on the lonely islands. The name *Galápagos* is based on a Spanish word for "tortoise." The Galápagos Islands have many unusual animals, other than the large turtles, including an ocean-going lizard that eats seaweed. Although most people think of penguins as being residents of colder climates, one species of penguins lives on the Galápagos Islands, which are almost exactly on the equator.

16 Until the Spanish discovered the islands, they were uninhabited by humans. The animals of the Galápagos had not developed a fear of humans, so the sailors were not recognized as threatening. For years, the giant turtles of the Galápagos died at the hand of sailors. Sailors captured the animals and took them aboard ship where they were later killed and cooked. Thousands of Galápagos turtles died in this way. Today, the country of Ecuador governs the islands. Ecuador limits travel to the islands and protects the animals.

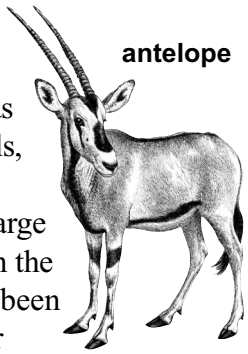
17 ***Crocodiles*** are reptiles, along with turtles, lizards and snakes. Crocodiles are large animals with an overgrown-lizard appearance and are noted for their powerful jaws filled with pointed teeth. A crocodile has a long, massive tail and four short legs that end in clawed, webbed toes. Crocodile skin is covered with scales as hard as bone. Crocodiles live in rivers, swamps and marshes worldwide in both tropical regions and warmer temperate zones.

18 From their teeth alone, biologists can tell that crocodiles are ***carnivores***. The teeth are sharp and pointed. Teeth in their upper and lower jaws slide past one another for cutting through meat.

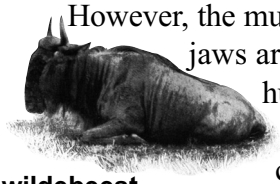


crocodile

The teeth of crocodiles vary greatly from the teeth of cattle. In animals that eat vegetation such as cattle, the teeth are flat and broad. Cattle teeth do not slide between one another. Instead, the teeth come together to grind and crush vegetation.


antelope

19 Crocodiles eat a wide variety of other animals, such as birds, turtles, frogs and mammals, including humans. Larger crocodiles can eat animals as large as an antelope or ***wildebeest***. In the United States, crocodiles have been found with dog collars in their stomachs, proving that crocodiles also eat domestic animals. The powerful crocodile jaw muscles close in a crushing grip on prey. However, the muscles for opening the jaws are weak. Crocodile hunters can take the animals alive by catching them with their mouths closed and then slipping bands around the jaws to hold them closed.


wildebeest

20 While crocodiles are good swimmers, they can also walk and run on land. Should their pond dry up during a drought, crocodiles can trek for miles to a larger watering hole. On cold mornings, crocodiles lie along shorelines in the sun to get warm, however, they can suddenly slide into the water by a strong thrust from their clawed feet.

21 In the water, the tail of a crocodile provides motive power. A crocodile swishes its powerful tail back and forth to propel it through the water. When hunting in the water, a crocodile drifts along without swimming. It floats almost completely submerged. Only its nose, eyes and part of its back project above water. Because it is silent and patient, it is difficult to detect. It looks like a drifting log.

22 When an animal comes to drink at a watering hole, the animal often does not see the crocodile until too late. The crocodile's jaws grab the unsuspecting prey. If the animal is out of reach, the crocodile uses its mighty tail to bat the animal into the water. Once it has gripped the animal, the crocodile rapidly rotates in the water to drown the animal and tear it apart.

23 If it cannot consume an entire meal, the crocodile will pull the uneaten portion into its burrow. The home of a crocodile is a burrow dug into the bank of a river, just above the water line. In cold weather, a crocodile retreats into its burrow and hibernates.

24 Bryan said, "Maybe Del can squeeze through that upper window." The boys strained to stack a heavy a bench on top of a table. Tom stood on the bench, and Del climbed on Tom's shoulders to the window.

25 "Not a chance," Del reported. "It's just a tiny slit about four inches high and maybe a foot long." She and Tom climbed back down. Del suggested, "Maybe we can start a fire, and the smoke will alert someone."

26 "Or burn us to a crisp," Tom muttered. "Olsen claimed he would send someone for us. What if he was lying? Or what if he trips and breaks his neck or his partner decides to weight him down and drop him over the side of the boat? We could rot in here before anyone finds us!" bewailed Tom.

Life Principle



"Consider the turtle:
it has to stick its neck
out to get ahead."

—Anonymous

Lesson 9
Biology

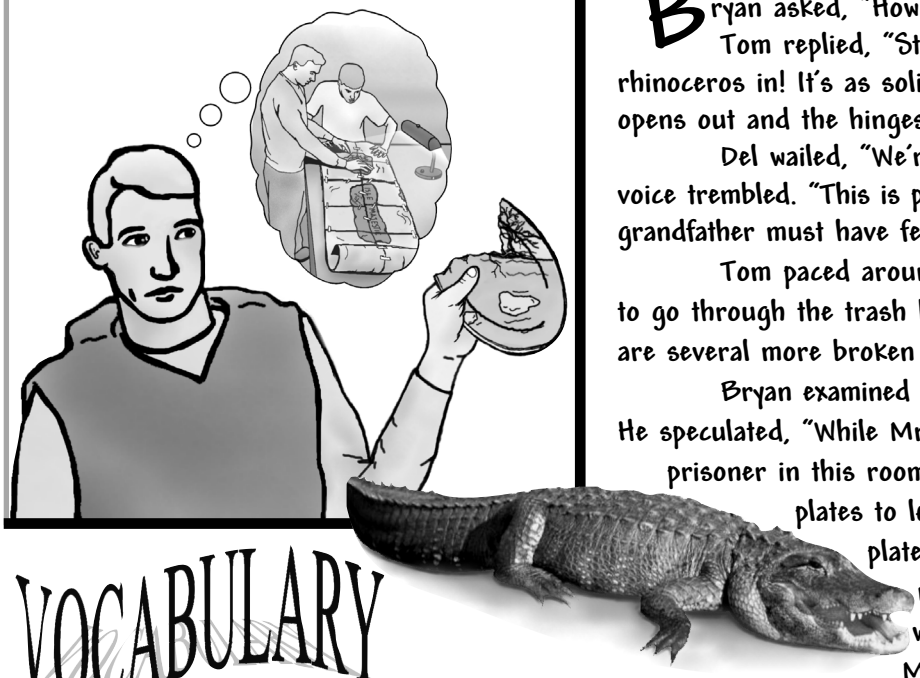
Chapter 5

Crocodile vs. Alligator Features, Range; Various Bird Features

Section 2

Lessons 6-10

CROCODILES, ALLIGATORS AND BIRDS



Bryan asked, "How solid is that door?"

Tom replied, "Strong enough to keep a rhinoceros in! It's as solid as this table. The door opens out and the hinges are on the outside."

Del wailed, "We're stuck in here!" Her voice trembled. "This is probably how my grandfather must have felt."

Tom paced around the room. He stopped to go through the trash bin. He said, "Look! Here are several more broken plates."

Bryan examined one of the pieces of china. He speculated, "While Mr. Murphy was being held prisoner in this room, maybe he broke the plates to leave a clue. Some of the plates shattered, and others may not have broken where he wanted them to. Maybe he kept trying until he got the one he wanted. Then he might have substituted the plate for the dollhouse, hoping that it would be a clue to the treasure or whatever he had found on Danger Island." Bryan looked thoughtfully at the plate in his hand. "That's odd—" he said.

"What?" Tom asked.

Bryan explained, "This plate broke exactly on the ancient twisted tree. Yet, he chose not to use it. His clue must be for some other feature near the twisted tree. We need to compare the plate back at the lodge with the French map—the one we gave to Del to translate the writing from French to English. I want another look at that map!"

Del interjected, "So do I, because the map is back at the lodge in my room. Get us out of here and you can have the map!"

VOCABULARY

Estuarine: animal life that lives in an estuary
Estuary: an area where fresh water and seawater mix, such as where a river runs into the sea and is met by tides
Alligator: a type of crocodile with a short, broad snout
Bayous (bi-oos): marshy areas, usually with stagnant water
Incubates: provides heat so eggs will hatch

Sometimes a small tree that grows in harsh conditions, such as the twisted tree on Danger Island, is older than a larger tree that grows in favorable conditions. The age of a tree is revealed by growth rings. A simple core sample allows a biologist to measure the age of a tree. Finding the age of animals is far more difficult.

Biologists cannot easily measure the normal life span of a reptile in the wild. Wild animals must be tagged and tracked for years. However, animals raised in zoos or wild animal parks can be studied throughout their lives. Their births and deaths can be exactly documented. Crocodiles kept in zoos or wild animal parks live about 40 years. Information gathered about animals that are kept in captivity does not always apply to animals that roam freely. Animals in enclosures seldom have the same diet and exercise as animals in the wild. Biologists think that once a crocodile becomes an adult, it lives longer in the wild than in captivity. The best estimates are that the maximum age for crocodiles in the wild is 65 years.

In ancient Egyptian times when the pyramids were built, the Nile crocodile was considered to be the largest living reptile. It lived along the Nile delta where the river emptied into the Mediterranean Sea. The largest Nile crocodiles reached a length of about 30 feet and weighed more than a ton (2,000 pounds.) The ancient Egyptians worshiped the crocodile. The Nile crocodile still exists but does not inhabit the lower Nile. Instead, it is found along the upper Nile and in several other parts of Africa. Modern Nile crocodiles do not grow to the large sizes that they achieved in past centuries.

Today, ***estuarine*** crocodiles that live along the coast of India are the heaviest reptiles. They can reach a length of 23 feet and weigh nearly a ton. The word *estuarine* is an adjective that describes an animal that lives in an ***estuary***. An estuary is the lower course of a river that is met by tides from the ocean. Usually, the water has a higher saltwater content than river water.

An ***alligator*** is a type of crocodile. Alligators can be distinguished from other crocodiles by the appearance of their mouths. Alligators have blunt snouts, while other crocodiles have longer pointed snouts. When alligators close their jaws, their lower teeth are covered. When crocodiles close their jaws, one tooth on either side of their lower jaws remains visible. This posture almost appears to be a smile.

American alligators live mainly in swamps and ***bayous*** in the southeastern United States, ranging from Florida to Texas. The American alligator can reach a length of 20 feet, including the tail.



alligator

VOCABULARY

Poachers: persons who hunt or fish out of season or in an area where hunting or fishing is not allowed

Birds: warm blooded, egg-laying vertebrates with wings and feathers

Nectar: a sweet liquid secreted by flowers of various plants; insects and hummingbirds attracted to the flower for the nectar aid in the pollination of flowers; bees collect nectar to make honey

Gullet: passageway for the intake of food; the throat

Crop: a pouch in the esophagus in birds, above the stomach that begins digestion of food; birds can bring up food from the crop to feed their young

Gizzard: a muscular chamber after the stomach of a bird that crushes food; the gizzard does the crushing with grit and pebbles that the bird swallows; a second or lower stomach in birds

Syrinx: the voice box of a bird

Alligators and crocodiles reproduce by laying eggs. The female makes a nest by first wallowing out a shallow depression in soft soil near water. A female can lay as many as 100 eggs. After she lays the eggs, she covers them with sand or mud. The heat of the sun, rather than her body, ***incubates*** the eggs. In cooler climates, alligators cover the eggs with vegetable material such as stalks and leaves. The female uses her tail to splash water over the nest. The water helps cause the vegetable matter to decay. The decaying material generates heat that warms the eggs.

Females stay near their nests and drive away animals that try to steal the eggs. The hatchling baby alligators each have a special hard tip on their snouts for cutting through the eggshells. When the babies are ready to hatch, they start making noises. This signals the female to uncover the eggs so the hatchlings can scamper into the water. However, once the little ones leave the nest, the female does nothing else to help them.

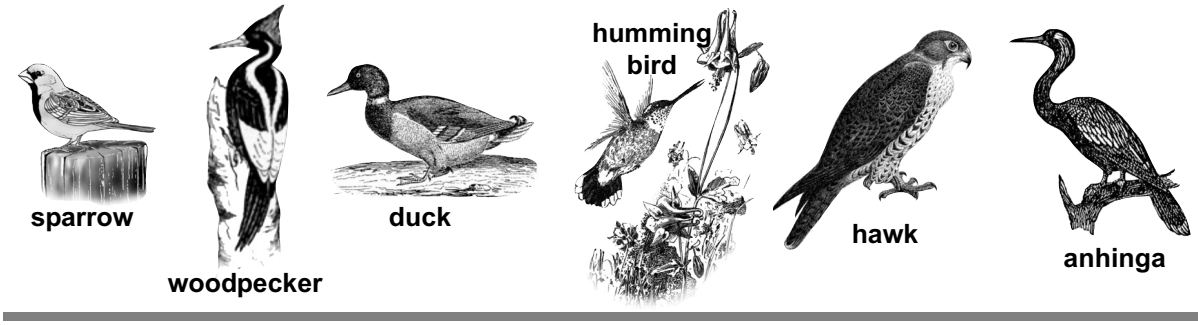
Many species of crocodiles and alligators are endangered because of loss of habitat caused by civilization along rivers. Alligators are also killed for their skins, which provide leather for shoes, boots, belts and luggage. Because of over-hunting, the American alligator was declared an endangered species in about 1960. State and federal wildlife agencies helped restore their numbers. Private alligator farms raised alligators for their hides and as food. The farms reduced the number of wild alligators illegally killed by ***poachers***. In some states, hunting of American alligators is once again allowed.

Birds, like fish, amphibians, reptiles and mammals, are a type of vertebrate. They differ from other vertebrates by having feathers that cover their entire bodies, except for their legs and beaks.

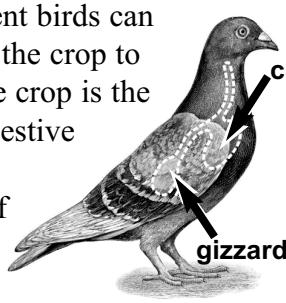
Knowledgeable bird watchers can identify many birds by their distinctive beaks.

Each type of bird has a beak uniquely designed for a particular type of food. The sparrow has a small, short but powerful, cone-shaped beak for cracking the outer husks of seeds. The woodpecker has a strong, pointed beak for pecking into wood to find insects. The duck has a flat beak for ripping up grass and weeds. The humming bird has a long, thin beak that is like a hollow straw, so that the humming bird can sip ***nectar*** from flowers. Owls and hawks have sharp, hooked beaks for ripping flesh from animals. The pelican has a long, straight beak with a pouch of skin below it for holding fish. Other fish-eating birds have pointed beaks that act as spears.

One example of a bird that spears fish is the *anhinga* found in Florida, also called *snakebird* and *darter*. The anhinga has a long, sharp beak and powerful neck. It has black feathers that make it nearly invisible as it swims silently underwater. When a fish is located, the anhinga pulls back its neck and then thrusts its head forward suddenly to spear the fish. Next, the bird swims to the surface and flips the fish into the air. The anhinga opens its beak, catches the fish and swallows it whole.



The throat of a bird is called a ***gullet***. The food passes through the gullet to the stomach, which is divided into three separate chambers. The ***crop*** is the first chamber. It serves as a temporary storage area. Birds that have young hatchlings use their crops to carry food back to the nests. Parent birds can cast the food back up from the crop to feed their young. Below the crop is the main stomach that adds digestive juices to the food.

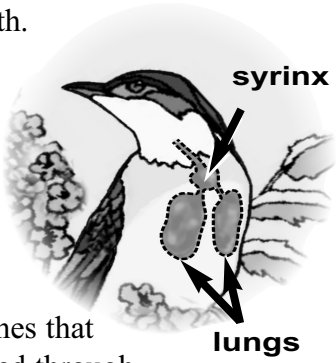


The third chamber of the bird's stomach is the ***gizzard***. Birds are warm-blooded. They need a lot of food to maintain their bodies at the right temperature. They also need energy from food to fly, and for other aspects of their active lives. To digest food quickly, the food must be broken up and mixed thoroughly with digestive juices. Birds have no teeth with which to chew food and mix it with digestive juices. Instead, the gizzard is designed to grind food into a digestible mush.

The gizzard has muscles surrounded by a tough, horny lining. The bird picks up coarse sand and pebbles of the right size and swallows them. The gravel is kept in the gizzard. Muscles cause the gizzard to contract and grind against hard foods such as nuts and seeds. The crushing action improves digestion.

Many birds, such as finches and sparrows, are seed eaters. Seeds are often coated with hard shells and would pass undigested through the bird's system. The grit in the gizzard mechanically grinds up seeds and makes them easier to be digested in the intestines where the bird's blood receives nutrients for energy.

The gizzard helps a bird achieve flight by eliminating extra weight. The gizzard is lighter weight than two large jaws and a mouth full of teeth. By using a beak designed for gathering food and a gizzard for crushing it, the bird is able to digest food quickly but does not have the added weight of heavy jawbones and teeth.



Birds make a wide range of sounds. The organ that makes bird calls is the ***syrinx*** and it is located in the windpipe. Stretched across the syrinx are two membranes that vibrate when air is forced through them. The bird can make the membranes tighter or looser and thus achieve a range of tones. Some birds can control each membrane independently of the other and achieve a complicated pattern of sounds. Each bird has a distinctive call. Experienced bird watchers can identify birds by their songs alone.

Bryan's mind was busy assessing the group's dilemma and available resources. He eyed the long wooden bench that had been so heavy to lift. Bryan and Tom had struggled to set it on top of the table. Suddenly, Bryan's face brightened. He motioned to Tom, "That bench would make a battering ram! Give me a hand!"

With renewed hope, the boys lifted the bench and made a running dash at the door. The bench crashed into the door and bounced back, tearing itself from their hands. The bunker resounded with the echo of the impact.

"What a racket!" Tom exclaimed. The boys pulled the bench back as far as they could, then again ran forward to slam it into the door. The door shook but held firmly.

LIFE PRINCIPLE



"He that can have patience can have what he will."

—Benjamin Franklin

Lesson 10
Biology

Chapter 5

Characteristics of Migratory Birds

Section 2

Lessons 6-10

BIRDS



The boys continued to pound at the door with their battering ram. Suddenly, Del yelled, "The mortar between the stones by the lock is coming loose! Hit it a couple more times!"

Bryan and Tom stopped to catch their breath, then set to work with renewed vigor. Suddenly, the stone around the lock crumbled, and the door swung out. They were free!

Before they left, Bryan examined the lock on the door. He said, "This is a combination lock similar to the one that Ranger Stewart used to lock the tool shed."

At the top of the stairs they peered out to make certain James Olsen had left. The only sound was the honking of a V-formation of geese flying south. Bryan pointed to them. "That's another sign that the time is short. I'd like to solve the mystery before we have to leave for home."

Tom said, "Are you going to tell Ranger Stewart about this?"

Bryan said, "I would rather wait until my uncle returns and tell him. Right now I want to compare the cracked plate with the French map."

Back at the lodge, Del said, "I'll get the map and meet you in the dining room."

Bryan and Tom entered the dining room. They were surprised to see by the clock that it was only mid-morning. Tom said, "Ranger Stewart is probably looking for us and wondering why we have not finished putting up the signs."

"Uh-oh," Bryan said. He pointed to the stand on the fireplace mantle. "The plate is missing. Either James Olsen or his partner must have gotten here before us and stolen the plate!"

VOCABULARY

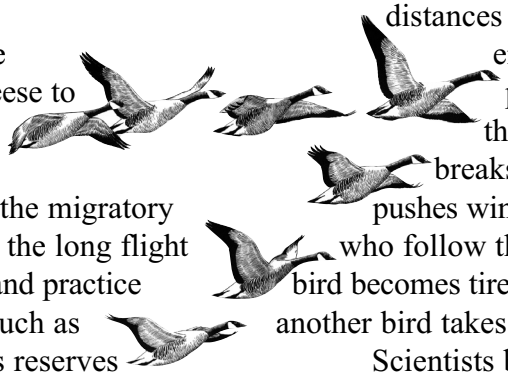
Tailwind: a wind blowing in the same direction as the course of travel

Flyway: the seasonal route followed by migrating birds; birds normally follow the same flyway each year

Goslings: young geese

Plumage: the feathers of a bird, especially relating to style and color

As Bryan paused at the top of the stairs from the bunker, he saw a V-formation of Canadian geese going south. Geese migrate from Canada to the southern United States in the winter. The flight south begins during late fall. As the Sun's rays become more slanted, daylight hours grow shorter. The temperature becomes cooler and food is harder to find. All of these factors signal the time for geese to go south.



Each fall, young geese that have never made the migratory trip instinctively prepare for the long flight by making short test flights and practice landings. The birds eat as much as they can to put on rich fat as reserves of energy.

Sometimes Canadian geese will wait for favorable weather conditions. A strong wind in the right direction will speed the birds on their way. High in the sky, the winds are generally twice as fast as at the surface of the Earth. If the wind on the ground is 10 or 15 miles per hour, then at 3,000 feet the winds are likely to be 20 to 30 miles per hour.

A common flying speed for ducks and geese is between 40 and 50 miles per hour. If they flew 10 hours a day they would go 400 to 500 miles in a single day, and that is without a ***tailwind***. By the help of a tailwind, birds could fly south very quickly. They could make the long journey in four or five days. They seldom do that, however. Geese may take a month or more to migrate south.

Because of inexperienced young birds, the flock flies slower and stops to rest and feed more often. Their route is not a direct one. Flock leaders take side trips as if helping the young birds learn other places to land. If plentiful food is discovered, geese may stay in a specific place for several days. Because they like open water, geese stay ahead of freezing weather. When the temperature drops below 32ºF and ponds start to freeze, geese hurry farther south.

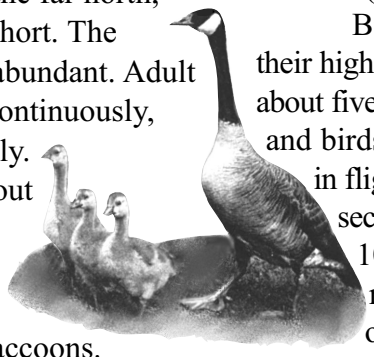
Birds in flocks can fly faster than a single bird flying alone. Flocks fall into a V-shaped formation. The V-formation is a scientific shape that helps geese fly longer distances at a faster speed with less energy. The lead bird at the point of the V has to give the most effort because he breaks the wind. The V-shape pushes wind outward away from geese who follow the leader. When the lead bird becomes tired, he drops back and another bird takes over as flock leader.

Scientists believe migrating birds use a variety of clues to find their way. The birds appear to observe the Sun, Moon and stars. They seem to watch for landmarks such as rivers and lakes. Some birds may use built in magnetic compasses to set their course. Scientists have discovered that many migrating birds have a bit of magnetic material in a certain place in their brains. Their brains may use the magnetic field of the Earth as a navigation tool. This built-in compass lets migratory birds fly day or night.

Once they learn a route, birds tend to stay with it. Each flock of geese has their own ***flyway***, a route they follow from one year to the next. Usually the flock will come to rest in the same place as they had the previous winter. During their winter vacation, the geese regain weight that was lost during the trip south. Geese eat grains, water plants, worms, insects, and crayfish.

Birds migrate between feeding and nesting grounds. Often, the distances between the two areas are hundreds or even thousands of miles. When spring comes, geese prepare to fly north to their nesting grounds. The return trip is a more direct route. The young ones are older and stronger. The flock can fly greater distances with fewer rests.

Geese live in wetlands and build their nests on low mounds. Female geese lay five or six eggs. Unlike fish, amphibians and reptiles, birds care for their young after they hatch. Bird parents provide food and stay with their young until they grow flight feathers. During summers in the far north, days are long and nights are short. The weather is warm and food is abundant. Adult birds feed the young almost continuously, and the hatchlings grow rapidly. ***Goslings*** are able to fly in about 40 days after hatching.



Until they can fly, goslings are in danger from predators such as foxes and raccoons. Geese defend their nests from invaders by hissing and biting. Approaching a nest too closely results in a loud hiss from the goose and a vicious charge that makes predators back away.

Adult geese cannot fly during their annual molt. Adult birds molt to replace feathers that have become frayed and worn and grow new ones. Some birds do not drop their feathers all at once. Their molt is spread over several weeks so they can continue to fly. However, birds such as geese, lose so many feathers during their molt that they cannot fly and are temporarily grounded.

In the far north, flightless geese are safer because they have fewer enemies. Although predators are a threat, harsh winters keep the predator population small compared to the total geese population. By not staying in an area year-round, the geese deny predators a dependable food supply.

The *Arctic tern* breeds in the southerly reaches of the Arctic and winters in Antarctic. The term makes the longest annual migration of any bird. Each year, its two flights from north to south and back again take it a distance of over 20,000 miles.

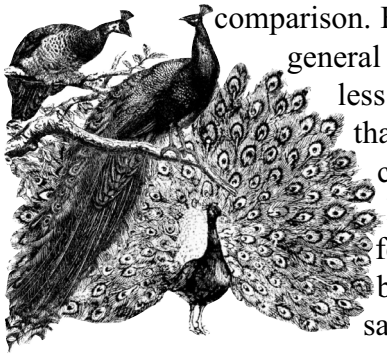
Birds are warm-blooded vertebrates. They maintain a constant body temperature. Most species of birds have a set temperature that ranges between 104ºF and 108ºF. The set body temperature of birds is five to ten Fahrenheit degrees higher than that of humans (98.6ºF).

Birds live at a fast pace to maintain their high body temperatures. Bird hearts beat about five times as rapidly as the human heart, and birds breathe more quickly, too. A bird in flight breathes in air seven times per second and has a heart rate of about 10 beats per second. Even when running, a human breathes about once per second and the heart seldom beats more than three times a second.

Feathers are excellent insulators and prevent the loss of body heat. Each feather consists of barbs on either side of a hollow shaft. Although strong, they are lightweight and filled with air holes. Feathers keep birds warm while flying through cool air.

Feathers serve other purposes for the bird. Feathers give birds in flight a streamlined shape to reduce air friction. Feathers at the tips of the wings and those in the tail serve for balancing and steering. Water birds have feathers coated with oil that sheds water. When swimming or diving, feathers keep birds dry.

Feathers also differ between male and female birds. Usually, males display brighter and more distinctive ***plumage*** as seen in peacocks. Their mates (peahens) are drab in comparison. Female birds in general tend to be much less brightly colored than their male counterparts. Feathers of females are often brown or gray, the same color as their



nests. The drab colors aid females in being inconspicuous when predators are nearby. Should the nest be threatened, the more brightly colored male will distract the predator and lead it away.

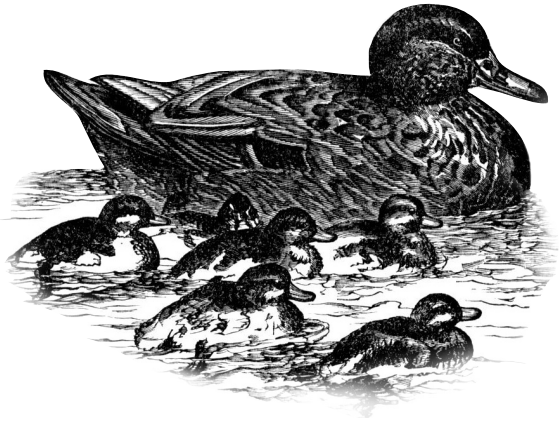
Birds eat foods that provide high-energy, such as seeds and insects. Provided they have enough food for energy, most birds can survive cold weather. However, even when food is plentiful, many bird species are programmed to travel to breeding grounds a great distance from their feeding grounds.

The blue china plate should have been on a stand under the photograph of Mr. Murphy; but the stand was empty. When Del returned with the map, Tom informed her that the blue souvenir plate was missing.

She smiled knowingly and said, "Weeks ago I realized the plate might be a clue. So, I hid it in my room and replaced it with a new plate. Here is the one we need." She carried the plate, wrapped in newspaper.

Bryan, Del and Tom compared the broken plate with the photocopy of the French map. Bryan said, "The actual break in the plate is north and west of the twisted tree. Is there a feature on the map in that location?"

Life Principle



"If you wish to go where there is no path, make one that others may follow."

—Anonymous

Lesson 11
Biology

Chapter 5

Single-most Distinguishing Factor: Milk Production; Unusual Examples

Section 3

Lessons 11-15

MAMMALS





VOCABULARY

Lactose intolerance: condition of individuals who cannot convert lactose in milk or milk products into glucose

Lactose: a sugar that is found in milk; also known as *milk sugar*

Glucose: a sugar that provides energy for cells; also known as *blood sugar*

Mammals: warm-blooded vertebrate animals; the female of the species has milk-producing mammary glands for nourishing the young mammals; females give live birth to the young with two exceptions (platypus and spiny anteater)

While Del, Bryan and Tom spread the map out on a table in the dining hall, Mrs. Murphy supplied them with a morning snack. She had milk and fresh-baked cookies. She joined them in drinking milk, but she poured her milk from a milk carton that was colored differently from the one used by the young people. 1

Del explained, "Grandmother has a digestive condition that requires her to drink a special milk." 2

Del, Bryan and Tom compared the French map with the diagram of the island on the souvenir plate. Del said, "On the French map, the feature just north and west of the twisted tree is *tonnerre trou*, which means *thunder hole*." 3

Bryan said, "The captain of the excursion ferry talked about the thunder hole. He said that sometimes a sinkhole connects to the ocean by a cave system. When waves crash into the opening at sea level, the sound carries to the surface through the sinkhole. It sounds like thunder." 4

Tom added, "But, no one has heard the thunder hole by the twisted tree in years. The ferry captain said something must have collapsed." 5

Bryan reasoned. "The fact that it once existed proves that the island has a cave system. There may be other entrances." 6

Tom asked, "But, where?" 7

Bryan thought a moment and then said, "You may have found one and did not realize it. Remember the Viking runes you discovered on the stone slab in that ravine? The meaning of the letters was "gateway" or "portal." That could be the entrance! We need to explore that hidden valley again and see if there is another entrance to the cave system!" 8

Tom said, "Ranger Stewart will not approve it. It must be on his clipboard list or he will never agree." 9

10 "We can't wait!" Bryan exclaimed. "James Olsen and his partner—." Suddenly Bryan broke off in mid-sentence. Then, just as suddenly, words excitedly tumbled from his mouth. "I know why they stole the hard hats with lights, generator and rope. They need that equipment to work in a cave! They have figured out the location of the treasure!"

11 Mrs. Murphy had a condition described as ***lactose intolerance***, which explained why she had to drink the special milk. ***Lactose*** is a sugar contained in milk, and is sometimes called *milk sugar*. The body can convert lactose into ***glucose***, which is the source of energy for cells. Most human infants digest lactose easily, whether from mother's milk or from goat's milk. The milk of cows is harder to digest. As humans grow older, however, some lose the ability to convert lactose into glucose, so they cannot digest milk. This means that foods containing milk, such as cheese and ice cream, also present digestive problems.



12 One treatment for the person who is lactose intolerant is to take the lactose enzyme, lactase, with each milk product consumed in order to break down lactose. Another solution is to treat milk so the lactose is changed into the more easily digested glucose. Many supermarkets carry milk which has been treated to change lactose into glucose. The third option is to avoid dairy products altogether.

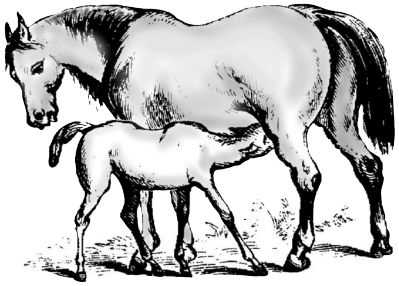
13 Animals with backbones include fishes, amphibians, reptiles, birds and ***mammals***. The word *mammal* is from a Latin word referring to "glands that produce milk." One way mammals differ from all other animals is that the young are nourished by mother's milk. Breast-fed human babies are usually healthier, smarter and less susceptible to diseases and germs. Milk is usually composed of 80 to 90 percent water. Dissolved in the water are protein, sugar, fat, vitamins, and minerals such as calcium and phosphorus.

14 The amount of each component in milk varies depending on the species of mammal. For example, some mammals live in cold climates or dive in cold water. A thick layer of insulating fat, called blubber, protects animals such as seals and beavers against the cold. Mothers of young seals are designed to provide milk that is high in fat so the young can develop the insulating layer of fat. The milk of seals is about 40 percent fat. It is as

VOCABULARY

Offspring: the young of any species
Casein: a complete protein that is present in milk
Amino acids: 20 chemicals made of carbon, hydrogen, oxygen and nitrogen that link together to make protein; amino acids are the building blocks of tissues
Essential amino acids: nine amino acids that cannot be produced by humans or animals but can be produced by various plants during photosynthesis
Carnivorous: flesh eating
Complete protein: a protein that contains the nine essential amino acids; casein in milk is a complete protein
Unique: one of a kind, no other like it
Platypus: a mammal of Australia and the island of Tasmania that lays eggs; also known as a *duckbilled-platypus*
Spiny anteater: a mammal native to Australia, the islands of Tasmania and New Guinea; an anteater lays eggs and has a long sticky tongue for catching and eating ants

thick as melted ice cream. Reindeer live in the far north of Europe and Asia. In Canada and Alaska, a similar species is called *caribou*. Reindeer and Caribou produce milk that is about 20 percent fat.



15 Mothers of animals that need to grow rapidly and run quickly are not designed to supply as much fat. Horses, for instance, are on their feet within minutes after being born. Mares (female horses) provide their ***offspring*** with milk that is only about one percent fat. In drinking the mother's milk, the offspring receives a greater proportion of sugar for energy, calcium and phosphorus for building bones, and protein for growth.

16 All milk contains ***casein***, a protein. Casein, like other proteins, is made of ***amino acids***, the building blocks of tissues. Amino acids are necessary for the growth and development of baby mammals. Chemists have identified 20 amino acids. Mammals can put together simpler compounds to make 11 of the 20 amino acids. Mammals cannot make the other nine amino acids.

17 Plants, through photosynthesis, can produce the nine amino acids, called ***essential amino acids***. Animals eat plants to receive amino acids. ***Carnivorous*** animals eat the flesh of other animals that have eaten plants. Animals can combine the nine amino acids from plants to make protein. A ***complete protein*** contains all nine of the essential amino acids. Female mammals produce casein, a complete protein that goes into their babies' milk.

18 The single characteristic that is true of all mammals is that the female of the species provides milk for her offspring.

19 Mammals have other traits, but in many cases, those traits are not ***unique***. Other vertebrates that are not mammals may have those traits, also. For instance, all mammals are warm-blooded. However, they share that feature with birds. Female mammals and sometimes the males take active roles in protecting and training their offspring. Birds, too, tend to their offspring until they are old enough to fend for themselves.

20 Mammals have four-chambered hearts. The heart is a muscular organ that pumps blood to all parts of the body. A four-chambered heart is divided into two pumps that work at the same time. The left portion takes oxygen-rich blood from the lungs and pumps it to the rest of the body. After passing from arteries to capillaries and to the cells, the exhausted blood is returned by veins to the right side of the heart. The right side takes in oxygen-poor blood from the body and pumps it to the lungs where it releases waste gases and gains oxygen.

21 Birds also have four-chambered hearts. Crocodiles are the only reptiles with four-chambered hearts. All other reptiles, amphibians and fishes have hearts that do not fully separate the two paths of the blood. Blood rich in oxygen from the lungs or gills mixes with blood that has passed through the animal's body.

22 Sometimes a feature is true for the majority of mammals, but not for all of them. For instance, most mammals are covered by hair. Whales are one exception. They are definitely mammals because they maintain a constant body temperature, have a four-chambered heart, give birth to live young and nourish them with milk. Yet, adult whales are devoid of hair.

23 In the 1800s, biologists had to decide if the ***platypus*** should be grouped with the mammals. The platypus lives in Australia and Tasmania, a large island south of Australia. The platypus is covered with fur, has a four-chambered heart, and is warm blooded. However, the platypus lays eggs instead of giving birth to live young.

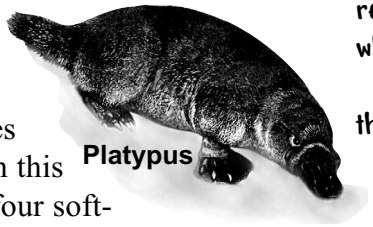
24 The first reports from explorers in Australia described the platypus as a puzzling patchwork. It had the thick fur and flat tail of a beaver, webbed feet and a bill resembling that of a duck. The male had sharp leg spurs like a rooster and dispensed poison through the spur's hollow part on each hind leg, which connected to a poison gland. The venom was powerful enough to send a person to a hospital (although no one has ever died of a platypus strike). The animal made a sound like a growling dog.



Spiny Anteater

25 The first platypus was captured and its skin sent back to England for study in the early 1800s. The bill had dried to become hard like that of a duck. However, the bill of a living platypus is covered with soft, leathery skin filled with nerve endings. When the platypus slides into the dark, muddy waters where it feeds, the sensitive bill can feel through the mud and detect worms, grubs and water insects.

26 The platypus lives below ground in a long, winding tunnel with an entrance from a river or stream. The female widens a chamber in the tunnel and lines it with leaves and shredded grass. In this nest, she lays two to four soft-shelled eggs. Each egg is about the size of a grape. Instead of sitting on her eggs, the mother platypus curls around the eggs.



Platypus

27 Despite laying eggs, the platypus is classified as a mammal, because the mother secretes milk for the newly hatched offspring. However, because she has no teats for dispensing milk, the little platypuses lick the milk from the belly hair of the mother.

28 Of the 5,000 species of mammals, only two lay eggs: the platypus and the ***spiny anteater***. The spiny anteater lives in Australia, too. The female spiny anteater lays one egg. After laying the egg, she places it in a fold of skin on her abdomen. After 10 days, the egg hatches. The little spiny anteater is carried in the mother's pouch for nine weeks. When the baby becomes too large to carry, the mother builds the youngster a nest of leaves. Mama anteater, like all mammals, is designed to provide milk for her offspring.

29 Bryan made a sudden decision. "We have to convince Ranger Stewart to search for the entrance to the cave system right away. He must listen to us!"

30 Ranger Stewart was working in his office, entering information into a portable computer. He wrinkled his brow in irritation at being interrupted, but he agreed to listen to the boys. Quickly, they told about the events of the last few days. Then, as Ranger Stewart asked questions, the boys described the earlier story about Mr. Murphy and his missing treasure.

31 "I've heard of it," Ranger Stewart said, "but I have a single concern. How did the thieves get into the shed? If you can give me a reasonable explanation of that, I'll give you whatever help you need."

32 Bryan took a deep breath. "Okay— I think I can do that!"

Life Principle



"Milk the cow which is near. Why pursue the one that runs away?"

—Theocritus



Lesson 12
Biology

Chapter 5

Features, Characteristics, Habitats, Range

Section 3

Lessons 11-15

KANGAROOS AND OTHER MARSUPIALS



Bryan said, "In the morning on the day we made the signs, Ranger Stewart unlocked the shed and left that open lock on a nail at the side of the building, out of our line of sight. Sometime during the day, the thief sneaked up and replaced the open lock with one of his own."

"Why?" Del asked.

Bryan explained, "Later, Tom locked the shed and didn't notice that the lock had been switched because they looked so much alike. That night the thieves came back, opened their lock—the one they had substituted—and took the things they wanted. Before they left, they locked the shed with Ranger Stewart's lock that they had taken earlier in the day and took their own lock back with them. When Ranger Stewart opened the shed the next morning, his lock was on the door."

Del said, "I understand. Tom actually locked the shed that night with the thieves' lock."

Bryan told Ranger Stewart, "We were locked in the bunker with a lock like yours, which must be the one they substituted for your lock."

Ranger Stewart grabbed his clipboard and began making notes. He said, "Let me make some telephone calls."

In short order, Ranger Stewart had called the coast guard to be on the lookout for the cabin cruiser used by James Olsen and his partner. The ranger also ordered equipment that he and the boys would need for exploring the cave to be put aboard the ferry and brought directly to Danger Island. Ranger Stewart then put out a call for an experienced cave explorer who had been trained in cave ecology.

VOCABULARY

Marsupials: mammals that give birth to live young; additional development occurs as the young are carried in a pouch on the mother's abdomen; examples of marsupials include kangaroos and opossums

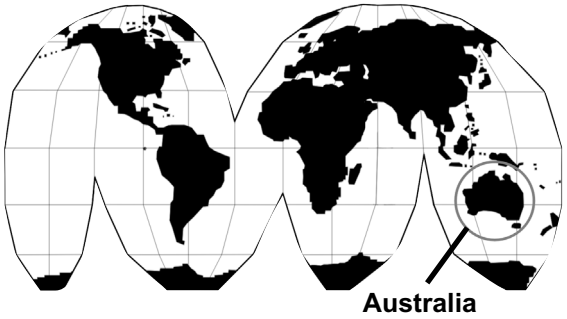
Kangaroo: a marsupial of Australia and surrounding islands; noted for its ability to move quickly by hopping with its long, powerful back legs

Wallabies: kangaroo-like marsupials, usually more brightly colored than kangaroos; a medium-sized kangaroo

The ranger said, "In addition to our safety, we have to be concerned with not disturbing the natural features of the cave or animal life that we encounter. Small animals that make caves their home are in danger of extinction because their environment is so easily disturbed. Sometimes an entire species lives in only a small pool of water and is found nowhere else on earth. We would like to avoid causing them to become extinct."

Animals become extinct for a variety of reasons including competition with non-native species introduced by human beings, loss of habitat, over-hunting by humans, and competition with other species. The platypus of Australia appears to protect itself from a predator that has become extinct. The platypus digs an elaborate burrow with escape routes and special plugs that can block off the tunnels. The platypus appears to be protecting its burrow from an invading predator that it greatly fears. However, scientists know of no presently existing animal that threatens the platypus in its burrow. Biologists believe the platypus takes precautions against a particular animal that has become extinct.

Biologists know that several of the animals that once lived in Australia have become extinct. Most of the mammals of Australia are ***marsupials***. A marsupial is a mammal that gives live birth, but the offspring are not fully developed. When first born, marsupials are incredibly tiny. They weigh approximately one gram (about the size of a large almond). The newborns crawl to a pocket on the mother's abdomen. There, the babies attach to a nipple and drink milk while they develop further in the warmth and protection of the pouch. The best known marsupial is the ***kangaroo*** of Australia.



A kangaroo is a marsupial mammal with short front limbs, powerful hind legs designed for jumping and a strong, tapering tail. Scientists have identified about 47 species of kangaroos. The small ones are called *rat kangaroos*, those of middle size are called ***wallabies***, and the name *kangaroo* is used for the largest ones.

The kangaroo stands about six feet high when on its back legs and weighs about 185 pounds—about the same height and weight as many adult human males. Kangaroos live in the ***savannas*** of Australia. A

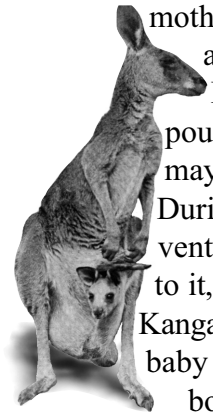
VOCABULARY

Savannas: flat grasslands found in warm climates
Tendons: fibrous tissues that connect muscles to bones
Joey: a baby kangaroo
Wombat: a marsupial of Australia that digs, burrows and eats roots, leaves and grass
Koala: a marsupial of Australia that eats leaves of the eucalyptus tree; sometimes called a *koala bear*
Opossum: the only marsupial found in the United States; the adult is about the size of a large cat with a long, rodent tail
Tasmanian wolf: an extinct marsupial of Australia and Tasmania with wolf-like characteristics
Dingo: a wild dog that is believed to have been carried to Australia by travelers to that continent during ancient times; the dingo caused some native marsupials to become extinct

savanna is open grassland with a tropical or warm, temperate climate. Kangaroos eat vegetation and graze on grass in the savanna.

When they need to move quickly, kangaroos hop on their back legs. Each hop propels the kangaroo about 30 feet. They can achieve a speed of about 30 miles per hour for short periods. Kangaroos are efficient at hopping because their ***tendons*** absorb the impact and then return the energy to their legs for the next hop. Tendons connect muscles to the bones of the skeleton. Kangaroos have stretchable tendons, unlike most animals whose tendons are not very flexible.

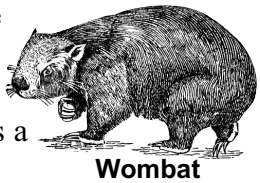
A female kangaroo has a pouch where a newly born kangaroo is protected and nourished. Once in the pouch, the young offspring, known as a ***joey***, feeds on its mother's milk until the youngster is able to obtain food for itself. Because of the protection the pouch provides, a young joey may live in the pouch for a year. During this time, the youngster may venture out of the pouch but return to it, should danger threaten. Kangaroos give birth to only one baby at a time. The next baby is not born until the joey is out of the pouch and weaned. An animal is weaned when it no longer drinks its mother's milk.



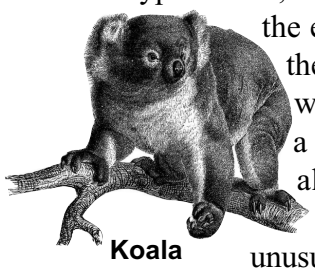
Female Kangaroo and Joey

Of the 47 species of kangaroos, about 10 species are endangered because of loss of habitat and competition with animals not native to Australia. European settlers began coming to Australia in 1788. They brought rabbits, dogs and cats, which are not native to Australia. House cats killed many of the smallest kangaroo species, the rat kangaroo. It is less than a foot tall. Dogs found wallabies easy prey. The kangaroos are larger and can defend themselves and are not in danger of extinction. Because they can tolerate people, kangaroos eat grass in parks, the lawns around suburban homes and invade golf courses. The main enemies of the larger kangaroos are humans. Farmers kill them because kangaroos eat the grass of pastureland and reduce the food available to livestock. Kangaroos are also killed for their meat and hides.

Other marsupials of Australia, Tasmania and New Guinea include the ***wombat***, ***koala*** and ***opossum***. The wombat is a burrowing animal that eats roots. The koala is sometimes incorrectly called a *koala bear* because it resembles a teddy bear. It is slow moving and spends days in a single grove of eucalyptus trees, eating leaves and flowers of the eucalyptus trees. Keeping the koala elsewhere in the world in a zoo requires that a source of eucalyptus trees also be provided for food.



Wombat

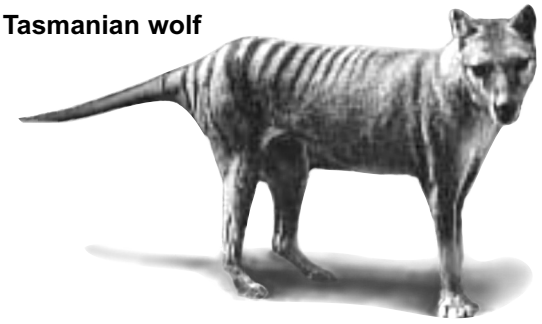


Koala

One of the most unusual marsupials of Australia and Tasmania was the ***Tasmanian wolf***. The female had a shallow pouch that opened rearward. In the pouch, she nursed two to four young at a time. The Tasmanian wolf was the size of a slender wolf and was carnivorous like the wolf. It had a brownish color fur with distinctive black stripes across its back and hunted birds at night. The Tasmanian wolf lived in Australia but could not compete with the ***dingo***, a wild dog.

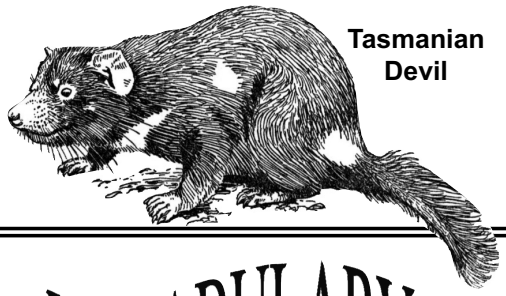
Although the Tasmanian wolf died out hundreds of years ago in Australia, it continued to exist on the island of Tasmania.

Tasmanian wolf



On the island, the wolves chief enemies were European settlers because the wolves threatened the settler's sheep. The last sighting of a Tasmanian wolf was in 1914. Occasionally after that, people reported seeing its tracks. Most biologists believe the last wild wolf became extinct in the 1930s. The last captive Tasmanian wolf died in 1936. However, Tasmania is a large island and some wolves may have survived in the back country. Biologists know what it looks like because the skins of some Tasmanian wolves have been preserved.

Another marsupial that became extinct in Australia, but not Tasmania, is the ***Tasmanian Devil***. The Tasmanian Devil is a carnivorous marsupial about two feet long and is related to the Tasmanian wolf. Like the wolf, a Tasmanian Devil female carries its young in a "backwards" pouch for about five months. The animal makes a harsh, grumbling cry and is noted for its bad temper. Nicknamed "Tas," it hunts sheep, wallabies and poultry. The Tasmanian Devil is also a scavenger. It eats animals that have died or been killed by other means. "Tas" has large jaws and strong teeth with which it eats entire animals including flesh, bones and hair. Australian farmers believed Tasmanian Devils killed livestock and chickens, and hunters completely exterminated the animal there. However, it survived on the island of Tasmania where it continues to live today.



Tasmanian Devil

The opossum is the only marsupial mammal of North America. The best known opossum in the United States is the Virginia opossum. The largest ones can be more than three feet long, although the tail is about half of that length. Although the tail is bare, the rest of the animal is covered with hair. On its back, the hair is long and sleek. On its abdomen, the fur is soft and wooly.

Despite the name, the ***range*** of the Virginia opossum is not just in the state of Virginia. It is found throughout the eastern and southern United States and south into Mexico and South America. The opossum is ***omnivorous***. The word *omnivorous* is from two Latin words: *omni* meaning "all" and *vorous* meaning "devour." An opossum eats nearly anything, both animal and plant. Opossums eat insects, small animals, eggs, fruit, berries and garden vegetables.

The expression, ***playing possum***, comes from a method the opossum uses to ward off a predator. The opossum takes advantage of the fact that many predators will eat only what they kill. Most predators will avoid eating an animal



Opossum

VOCABULARY

Tasmanian devil: a marsupial noted for its grumbling, angry cry and bad temper; it consumes all of its prey including bones; the Tasmanian devil once lived in Australia but today lives only on the island of Tasmania
Range: the entire region in which a particular species of plant or animal normally grows
Omnivorous: description of an animal that eats both plants and other animals
Playing possum: pretending to be dead, used as a defense mechanism

that died by any other means. The opossum turns on its side, closes its eyes and lets its tongue hang out. It stays motionless even when poked or pushed around. The opossum "plays dead". This action fools the predator into thinking the opossum is not worthy of eating.

Should playing possum not be appropriate for the threat, the opossum backs into a corner, opens its mouth wide to reveal all of its teeth and hisses at the attacker. Seen from the front, the opossum looks like a dangerous foe because of the large mouth and 50 sharp teeth.

The explorers were not able to enter the cave system where Tom had found the Viking writing until the next morning. Bryan and Tom were outfitted with hard hats and lights as well as ropes. Much to Del's disgust, the ranger had insisted that Del was too young to go into the cave. She remained at the lodge with the two-way radio in case of an emergency.

Ranger Stewart, the cave explorer, Bryan and Tom started out early, and by mid-morning had arrived at Tom's ravine. It was deep in shadows and well hidden from sight. The group struck a path under an over hanging rock, then deep into the valley. Tom excitedly pointed out the ancient "Viking billboard" he had accidentally discovered earlier that summer. The huge stone slab with runic writing and half-covered with moss, was still leaning against the old oak tree. Bryan darted about looking for a cave entrance. Between the oak tree and the ravine wall, he stopped suddenly. Cool air came up from a dark opening in the ground.

Life Principle

"The closer we get to know the creatures around us the clearer is the understanding we obtain of (nature's) harmony and system."



—Carl Linnaeus

Lesson 13
Biology

Chapter 5

Opossums and Placental Mammals

Section 3

Lessons 11-15

BELLY BUTTONS AND SHREWS



Bryan radioed Del and said, "We have found the entrance to the cave! As far as we can see with a flash-light, the opening is narrow with a twisting passageway that starts out nearly vertical. We can climb down among boulders, but we'll lose radio contact once we get into the cave."

Tom asked, "Does the cave have bats?"

The cave explorer said, "If it does, they will be asleep. They sleep during the day and look for food at night."



Ranger Stewart and the cave explorer checked and rechecked all of the equipment before they descended into the cave. The four of them worked their way into the dark slit in the rock for a couple hundred feet. Then, the opening turned into a narrow, horizontal passageway. In places, they had to crawl on their hands and knees.

The cave explorer said, "No one has been through here in years, if ever! I think this may be a wild goose chase."

Much to their surprise, Ranger Stewart came to the boy's defense. "If the cave system is extensive, then the thieves may have found another entrance."

After two hours of struggling along the narrow passage, the cave explorer called a stop. He said, "We need to rest and eat some food." He distributed power bars to everyone."

Tom said, "I'm not hungry."

"Eat it," the cave explorer commanded. "You need energy for the physical exertion and also to provide energy to keep your body warm, despite the chill of the cave." At the cave explorer's urging, everyone consumed their bars in the cramped quarters before pressing on.

VOCABULARY

Caver: one who studies and explores caves
Nocturnal: active at night
Opposable: to be on the opposite side; the thumb is opposable because it is opposite the fingers on the hand; the opossum has an opposable toe that helps it grasp tree branches
Prehensile: an organ such as the tail of a monkey or the trunk of an elephant that is designed for grasping or wrapping around objects; the tail of an opossum is *prehensile* and helps it climb trees

Somewhat refreshed, the group resumed their trek. After several minutes, the passageway seemed to be a little roomier. Suddenly, it emptied into a large room with a high ceiling. The guide stopped. He held his fingers to his lips to show they should be quiet. The air smelled of salt. They could hear the distant sound of waves striking the cliffs. Bryan whispered, "There must be another way in from sea level!"

Cautiously, the cave explorer, Ranger Stewart, Bryan and Tom pressed ahead. The tunnel was larger on this side of the room. The guide turned off his light and signaled the others to do the same. Ahead, the cave was lighted by a dim glow. The group silently approached the larger chamber. A generator hummed and sent electricity through a string of electric lights.

The cave explorer, or ***caver,*** described the bats as being ***nocturnal***. Animals that search for food at night are nocturnal. The word *nocturnal* is from a Latin word meaning "night". Bats are nocturnal, as are opossums. Opossums sleep during the day in the hollows of trees and stumps and among the roots, becoming active at night.

The opossum is a good climber because it has ***opposable*** toes on its back feet. Like a thumb that is opposite the fingers, the opposable toe helps the opossum grasp limbs. In addition to an opposable toe on each back foot, an opossum has a ***prehensile*** tail. A prehensile tail is one with muscles that the animal can control for grasping and holding things. The opossum uses it for hanging onto limbs as it climbs in trees.


opposable toe


Opossum

Some drawings show the young hanging from their mother's tail that she carries curved over her back. However, the fact of the matter is that mother opossums do not carry their young in this way.

Like all marsupials, newly born opossum babies are not fully developed. They are so tiny a dozen of them would fit in a tablespoon. They do have strong front legs that help them climb into their mother's pouch. Inside, the newborns enter a race for survival, because in a large litter, babies may exceed nipples in the pouch. The successful babies spend about two months in the mother's pouch before emerging. After that, they ride on the mother's back by holding firmly to her hair.

VOCABULARY

Placental: a mammal with a placenta (see below); except for the platypus, spiny anteater and marsupials, all mammals are placental

Umbilical cord: the connection between the naval of a fetus with the placenta of the mother; the umbilical cord contains arteries and veins for carrying nourishment to the fetus and for removing waste

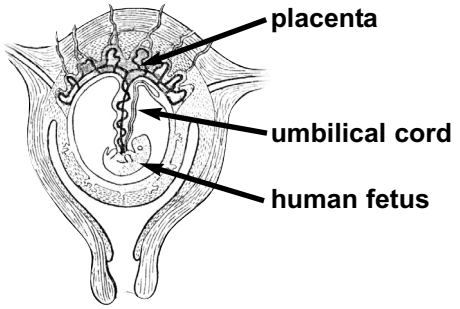
Placenta: an organ filled with blood vessels in a pregnant female mammal that is the site of the exchange of nutrients and waste products between the developing fetus and the mother

HIV: the virus that causes AIDS (Acquired Immune Deficiency Syndrome), a disease that is nearly always fatal; transmitted through body fluids such as semen

Fetus: an unborn mammal

Navel: the depression on the surface of the abdomen of a human or mammal that marks where the umbilical cord was attached; in humans, the navel is also known as the belly button

Except for the spiny anteater, platypus and other marsupials, all mammals (including humans) belong to a category that biologists call ***placental***. An ***umbilical cord*** connects the unborn baby to the ***placenta*** of the mother. The umbilical cord contains arteries and veins that form a lifeline between the mother and the baby.



The placenta is an organ inside the mother that is rich in blood vessels. The placenta develops once the female mammal becomes pregnant. Blood vessels from the umbilical cord branch into hundreds of smaller vessels. The vessels pass into sections of the placenta that hold pools of the mother's blood. Although vessels pass through the blood of the mother, the mother's blood does not mix with the baby's blood. Nutrients and oxygen from the mother pass by osmosis through the vessel walls. Going the other way, waste products such as nitrogen and carbon dioxide pass from the baby's blood vessels into the blood of the mother.

Because the blood of mother and unborn baby do not mix, the baby can have a different blood type. Diseases carried by the mother are less likely to infect the baby. However, the separation is not perfect. Many chemicals and some viruses can pass through the vessel walls. If the mother carries the ***HIV*** virus, the baby can become infected, too.

Drugs can pass through the vessel walls to the baby. Doctors recommend that human mothers not take drugs that might hurt the baby. Nicotine, the drug from tobacco, and illegal drugs such as cocaine, speed, ecstacy and heroine easily pass from mother to baby. Major health problems follow many innocent, but addicted, babies as they enter the world screaming from withdrawal pains. Alcohol is another drug readily absorbed through the walls of blood vessels. Doctors recommend that human mothers not drink alcohol while they are carrying a developing baby. To do so can result in severe health problems including low birth weight, deformities and mental retardation.

The developing human baby, called a ***fetus***, is attached to the placenta by an umbilical cord. The beating heart of the human fetus begins pumping blood through the umbilical cord and through its own body within two weeks after conception. By the fourth week the digestive organs, heart and brain are functioning—all before the woman even knows she is pregnant. The umbilical cord contains two large arteries that deliver oxygen and nutrients to the fetus. The umbilical cord has one vein that takes away waste products. Once transferred to the placenta, the mother eliminates the waste products.

An animal that has been attached to its mother by an umbilical cord is easy to recognize. After birth, the umbilical cord withers and falls away. It leaves a circular mark on the abdomen known as a ***navel***, also called a "belly button."

Mammals come in all sizes. Some of the smallest are ***shrews***. Shrews are common worldwide, except in Australia. In the United States, shrews look like small, nervous mice but have long, pointed snouts. Most shrews weigh less than half an ounce. Some weigh less than a dime. They are between three and five inches long, including the tail. Some species look


American Shrew

Elephant Shrew



quite different. The elephant shrew in Africa has a long, flexible snout and hops like a small kangaroo. Tree shrews that inhabit tropical rain forests in Southern Asia are small, squirrel-like mammals with bushy tails.



Tree Shrew

The shrew must eat constantly. It has no choice. Its body has a high ***metabolic rate***. A shrew's body changes food into energy quickly. The shrew's tiny heart beats 700 times a minute— a heart rate faster than that of any other creature. A shrew can sleep for only an hour before hunger drives him out of his den. He will die of starvation within twelve hours if deprived of food.

The shrew hunts almost constantly. Shrews hunt on the surface of the ground and in burrows and tunnels dug by other animals such as mice and moles. Shrews have thick, velvety soft-brown fur. The sleek fur and slender bodies enable shrews to glide silently through tiny tunnels and snatch out earthworms and grubs. Above ground, shrews overturn rotting limbs and leaves with frantic, twittering movements. The tiny carnivores dart at crickets and pounce on grasshoppers.

Scientists classify shrews as ***insectivores***: animals that eat insects, such as crickets, grasshoppers and beetles. Like most insectivores, shrews have a keen sense of smell. They have teeth as sharp as needles, and their front paws have fingers tipped with powerful claws. Shrews hunt both day and night. Biologists think the high-pitched chatter shrews emit is a method of ***echolocation***. The echo of a sound helps a shrew find prey in the dark, similar to the way bats navigate.

Shrews usually eat insects, but when they are extra hungry, they will turn to other food. Shrews must eat more than their body weight every day. This would be like a ten-year-old boy eating 120 pounds of food every day. The shrew will eat small vertebrates including mice and small invertebrates such as snails and earthworms. Shrews gobble down black widow spiders as easily as they do grasshoppers. Snakes that venture into their tunnels hunting for a meal have the "table turned" and end up as the meal, instead.

Shrews will eat plants, but some plants do not have enough food energy for shrews. Grass is low in protein and fat— good for livestock, but shrews could eat grass all day and then die of starvation. Shrews look for seeds that are packed with energy. They will search through a mouse's burrow looking for the storeroom of seeds. If they cannot find seeds, they will attack the mouse. A mouse might be twice as large, but

VOCABULARY

Shrews: small, mouse-like insectivores; shrews are the smallest mammals and live fast-paced lives that require them to eat more than their own weight of food each day

Metabolic rate: the rate at which energy is required by an animal to maintain its life functions; shrews have a high metabolic rate: they break down food quickly to provide energy

Insectivore: a carnivore that eats meat in the form of insects; many insectivores will also eat other small animals including earthworms, snails and small snakes

Echolocation: a method of locating obstructions or other objects by emitting a high pitched sound and interpreting the returning echo to learn the distance and direction

that does not matter. Because shrews are always hungry, they will eat fur, bones, and claws—everything.

Animals seldom attack the shrew because it is equipped with a gland that puts out a powerful musk smell like the odor of a skunk. Predators must have a strong stomach to eat a shrew. Another weapon of the shrew is its poisonous bite. The poison causes smaller enemies to become groggy but is only painful to humans.

A mother shrew is especially active in the spring when she has as many as nine youngsters to feed. Although they are smaller than bumblebees, together they demand as much food as their mother. She has to find twice as much food as usual. When the young are old enough to follow their mother, they form a line. The youngsters gently bite the tail of the sibling in front as a means of hanging on and not getting lost. The youngster in front holds the tail of the mother as she scampers among leaves in search of food for her family. Shrews have a life span of 14 to 18 months.

Bryan and Tom gaped in astonishment. The lights were strung around a Viking ship. It stood exposed on a rocky platform to one side of the chamber. Its mast was down, the oars pulled-in, and the usual rows of shields along each side were missing. However, the hull of the ship still appeared to be seaworthy.

The string of electric lights cast harsh shadows on the rocky walls of the cavern. Below the ship was an inky-black pool of water that gently rose and fell. A rope was connected to the front of the ship, and several wooden skids under the ship were oiled and tilted toward the water.

Life Principle

"Without observation and experiment, the mind goes astray after phantoms and appearances."



—William Harvey

Lesson 14
Biology

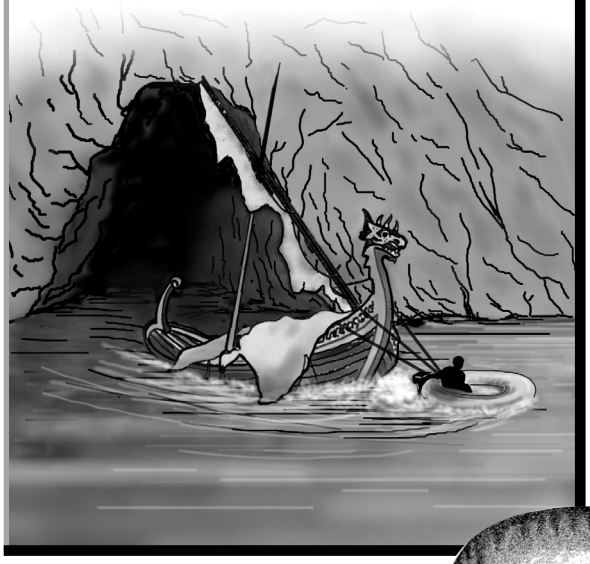
Chapter 5

Features of Burrowing Mammals; Characteristics of Bats

Section 3

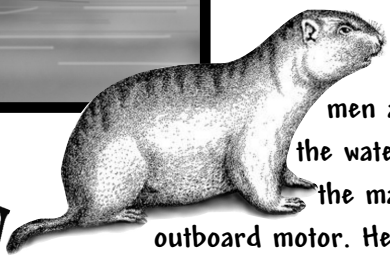
Lessons 11-15

MOLES AND BATS



The cave explorer signaled the others to follow him, as he worked around to a higher viewpoint. From there, the group could see into the ship. Much of a Viking ship's usual contents and gear were missing. Below, in the water, was a rubber boat with lots of heavy rope and an outboard motor attached. James Olsen's partner stood ready to crank the outboard motor into action.

Tom asked in hushed tones, "Why the ropes?"



Bryan whispered, "Apparently the men are going to try to slide the ship into the water and tow it out of here." As he spoke, the man in the rubber boat started the outboard motor. He gave a signal to someone out of sight in front of the Viking ship. James Olsen came into view, carrying a sledgehammer. He struck at a block holding the ship in place.

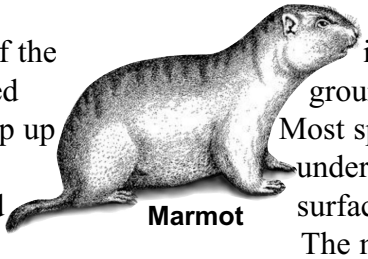
Before Ranger Stewart or the cave explorer knew what was happening, Bryan began running. Tom followed. They ran, bent over, in the shadows toward the Viking ship. A groan came from the ship as it began sliding into the water along the greased beam. In the shadows, Bryan and Tom scrambled, unseen, into the stern of the Viking ship. It gave a sudden lurch and crashed into the water sideways, causing a huge wave.

The man in the rubber raft began towing the ship through a narrow channel filled with water. Bryan and Tom lay on their backs and watched the roof of the cave pass overhead. Suddenly, they were staring up at a blindly bright sky. They were outside the cave and in open water!

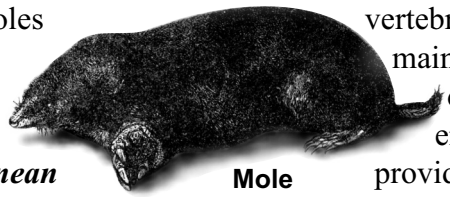
VOCABULARY

Mole: a mammal that lives underground and eats insects
Subterranean: below ground level; underground
Marmots: burrowing rodents, also known as *woodchucks* and *groundhogs*
Grubs: larvae of beetles; term is sometimes applied to the larvae of other insects
Bat: a nocturnal flying mammal
Colony: a group of animals of the same species living together

During their exploration of the cavern, the cave expert encouraged Bryan and Tom to eat food to keep up their energy levels and to protect against the cold. Animals eat food for energy to keep warm and to move about. Like the shrew, the ***mole*** lives a fast-paced life and has to eat its own body weight in food each day. Because of its small size, a mole's surface area is large compared to the volume of its body. The mole loses heat at a rapid rate, and therefore is constantly in need of food to maintain its internal temperature. Like shrews, moles must hunt both day and night. They rest only for short periods.


Marmot

The mole has a strong, bullet shaped body and powerful, shovel-like front feet with claws for burrowing. Moles have sleek, fine fur and powerful jaws. Because it spends most of its time in a dark, ***subterranean*** world, a mole's eyes are ineffective. Instead, moles detect danger by vibrations through the soil. The star-nosed mole has a series of sensitive projections on its nose that give it a strange look but a good sense of touch.


Mole

Moles dig two levels of tunnels. Those near the surface are used to scout across a lawn in search of food. Moles eat the roots of plants in gardens and burrow through the soil rapidly, producing a ridge on the surface. Moles produce vent holes in lawns for letting air into their tunnels. Homeowners dislike the ridges, holes and damage to their yards. Moles have their living quarters as much as ten feet below the ground and escape to these deep chambers when attacked by predators.

Many mammals dig burrows and tunnels to escape predators and provide dens in which to raise their young. Such mammals include prairie dogs, gophers, ground squirrels, mice and ***marmots***. Most spend only part of their time underground. They come to the surface for food.

The mole, however, is designed for an underground life. Some species of moles seldom come to the surface. Instead, they live on earthworms, plant roots and ***grubs*** of insects by burrowing under the soil. A grub is the larva of a beetle or other insect. A larva is a newly hatched, usually wingless form of an insect before it undergoes metamorphosis and becomes an adult. The larvae of many insects live underground around the roots of plants and trees.

All mammals share certain characteristics. All have backbones (they are vertebrates), all are warm blooded (they maintain an internal temperature that does not depend on the environment), all female mammals provide milk for the young, all mammals breathe air with lungs and all have hearts with four chambers. Most have hair or fur as adults. With only two exceptions (platypus and spiny anteater), they all give birth to live young.

The number of offspring produced by mammals is small compared to the offspring of other animals such as fish or insects. Mammals seldom have more than 20 offspring at once, and many give birth to only one or two at a time. Female mammals, and sometimes the males, protect the offspring. Young mammals are programmed to spend time with the parents and learn from them.

A certain kind of South American ***bat*** is the smallest mammal. It is about the size of a bumblebee. The largest mammal is the blue whale with a length of 100 feet and a mass of 150 tons. The blue whale is not only the largest mammal but also the largest animal

that has ever lived, even bigger than the largest dinosaur.

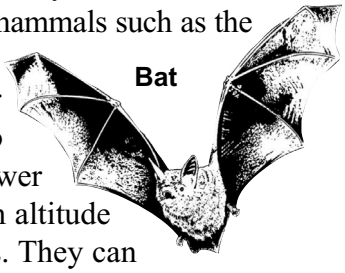
The shrew is believed to have the shortest life span of any mammal, seldom living more than 18 months. Larger animals usually live longer. The maximum age for a rabbit is about 15 years. Animals in the wild seldom die of old age, so learning the maximum age is difficult. If one particular rabbit manages to survive for 15 years, then dozens of others die before reaching that age. Domestic cats live about 20 years, horses about 40 years and elephants about 75 years.

The rate of normal heartbeat varies among mammals. Shrews have hearts that beat 700 times a minute. During its short life of 18 months, a shrew's heart will beat about 552,000,000 times, or a little more than one-half of a billion times. The heart of a cat beats about 130 times a minute. During a lifetime of 20 years, a cat's heart will beat 1,367,000,000, or a little more than one and one-third billion times. An elephant's heart beats at a slower rate of 30 times a minute, but during its longer life of 75 years, its heart beats about 1,183,000,000 times, or a little over one billion times.

Somewhere short of one and a half billion beats appears to be the upper limit of the number of times a mammal's heart can beat. The exception is the human heart. The human heart beats an average of 72 times a minute and the maximum age for a human is about 115 years. In that long lifetime, a human heart beats 4,533,000,000 times, or more than four and a half billion times. Even for the usual lifetime of 72 years, the human heart beats almost three billion times. That is twice as many beats as the heart of any other mammal. Long term human stamina is far superior to animals.

The total number of species of mammals is small compared to other types of animals. The number of mammal species is about 5,000, while about 800,000 species of insects have been described. The total number may be in the millions. Despite the smaller numbers, mammals are designed to survive in practically every habitat. Polar bears thrive in arctic cold. Camels are unaffected by desert heat. Mountain goats live in the thin air and rocky summits of high mountains. The sperm whale can dive to a depth of more than a mile in the ocean. Moles live underground, and bats take to the air.

Bats are the only mammals that can actually fly. Some mammals such as the flying squirrel only glide from a higher position in a tree to another tree at a lower level. Bats can gain altitude and are good flyers. They can change direction more sharply than birds. The wings of bats are made of skin covered with fine hairs. To spread their wings, bats open their front limbs. When their fingers open, the wings spread out like unfurling an umbrella.


Bat

Bats are divided into two groups depending on whether they eat fruit or meat. The fruit eating bats pollinate many tropical plants including bananas, dates and figs. They drink the juice of the fruit. A single bat may drink three times its body weight in juice in a single night.

Both types of bats feed at night. They are nocturnal. Most meat eating bats feed on insects caught in the air. However, one species of bat catches and eats fish, while vampire bats suck blood out of sleeping animals. Bats identify the direction and location of a flying insect by echolocation. In this process, bats emit high-pitched squeals that cannot be heard by human ears. Bats have a finely tuned sense of hearing and large ears designed for detecting the returning echo and sensing the direction of the insect.

In straight and level flight, bats can achieve a speed of about 20 miles per hour. Bats can fly quickly and turn sharply. When feeding, bats can capture about two insects every second. In a single night, a large colony of bats will eat millions of insects.

Because they use echolocation so well, many people think bats are blind. The expression "blind as a bat" is not correct. Biologists who have tested bat vision report that bats can see well in dim light. In fact, their eyesight is better than that of humans.

Bats spend the day in caves, abandoned buildings or other dark, out-of-the-way places. As many as 300 bats can roost upside down on a single square foot of a cave ceiling. A ***colony*** may have twenty million individuals (20,000,000) in a cave. In cold climates, the colony will hibernate. During winter months when flying insects are not available, bats pass the time in a deep sleep. During winter hibernation, their internal body temperature drops to near freezing.

The female bat usually gives birth to a single offspring. Because she must continue to hunt, the baby bat hangs diagonally across the mother's abdomen to keep the baby in balance during flight. When the baby grows older and heavier, it is left hanging upside down in the cave. The mother can return and immediately identify her own baby among the thousands of other baby bats in the same cave.

Bryan glanced around at his surroundings. He cautiously peered over the side of the ship and saw that James Olsen was transferring the towrope to the cabin cruiser. Olsen's partner stood ready to catch it. In just a moment, the more powerful motors of the cabin cruiser, rather than the outboard motor on the raft, would be pulling the Viking ship.

Bryan grabbed at a metal object he spotted in a holder along the inside of the wooden ship. The object was a gigantic sword and it was nearly as heavy as a sledgehammer! Crouching to keep himself and his weapon out of sight, Bryan worked his way toward the bow of the boat. Tom grabbed part of a broken oar and followed.

LIFE PRINCIPLE



"Life is as the flash of the firefly in the night, the breath of the buffalo in winter time."

—Blackfoot Native American Indian proverb

Lesson 15
Biology

Chapter 5

Categories of Mammals that are Aquatic, Gnawing or Carnivorous

Section 3

Lessons 11-15

WHALES, RODENTS AND CARNIVORES



James Olsen was about to reboard the Viking ship when he saw Bryan coming toward him, brandishing the Viking sword. Tom was close behind, swinging the broken oar. Olsen's eyes nearly popped out of his head. Hadn't he locked those kids in an underground bunker a few days ago? Olsen's brain vainly searched for an answer as Bryan advanced. Olsen saw by Bryan's serious expression that he meant business. Remembering he was unarmed, Olsen suddenly turned and jumped back into the rubber boat. He gave the engine gas and sped away. 1

Bryan hacked at the towrope with the sword. He was surprised at how difficult the rope was to cut. Suddenly, the line went slack. Bryan looked at the cabin cruiser and saw that the man there had released the towrope. Without hesitation the engines of the cabin cruiser roared into action as the boat sped away. 2

Bryan watched as the cabin cruiser cut a path in the water, then asked, "Why did he take off?" 3

Tom pointed to a ship bearing down on them. "Coast Guard!" he exclaimed. 4

The captain of the Coast Guard vessel had to decide whether to chase the cabin cruiser or rescue the Viking ship, adrift near dangerous rocks. A crewman fished out the towrope. The Coast Guard vessel took Bryan, Tom and the Viking ship in tow 5

VOCABULARY

Pikes: long,sharpen poles used by military in earlier times
Digits: fingers, thumbs or toes of primates
Primate: an order or classification of mammals with high intelligence, having forward facing eyes and opposable thumbs; biologists classify humans as primates

and quickly entered a sheltered cove. Bryan and Tom grabbed two long poles still resting against one side of the ship and used them as *pikes* to push the ship as near to shore as possible. The boys stopped when they heard the hull scraping against the pebbly surface below the shallow water.

6 "Wow!" Tom exploded with enthusiasm, "For a moment we were sailing a thousand year old Viking ship. Just call me Tom the Red!"

7 Bryan reflected, "I'm glad the ship is safe, but most of its contents are probably on that cabin cruiser."

VOCABULARY

Orders: categories of classifications of biological specimens between class and family; the broadest classification is kingdom, followed by phylum, class, order, family, genus and species; the common house cat is an animal (kingdom), chordata (phylum), mammal (class), carnivore (order), feline (family), domestic cat (species)

Stereoscopic vision: seeing the same object with two eyes; primates have stereoscopic vision which aids in accurately judging the distance of close objects

Whales: largest living mammals, spend their lives in the oceans

Calf: the young offspring of a whale; also applied to the young of cows and elephants

Blowhole: an opening in the top of the head of a whale for breathing; toothed whales have one blowhole, baleen whales have two blowholes

Blubber: a thick layer of fat between the skin and muscles of a whale; the body of a whale is insulated by the layer of blubber; the blubber also stores energy and helps the whale float

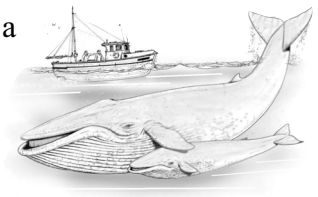
8 Bryan could handle the sword because of the design of his hand. Each hand has five fingers, or ***digits***. The thumb is opposite the four fingers. This allowed Bryan to grasp the sword.

9 Humans have hands with fingers similar to mammals that are in the order ***primate***. Biologists assign mammals into broad groupings known as ***orders***. An *order* is a division that is smaller than *class* but larger than a *family*. Primates are the order of mammals that show the greatest intelligence. They include monkeys and apes. Primates have eyes in the fronts of their heads. This gives them ***stereoscopic vision***. They see the same object with both eyes. Animals with stereoscopic vision have greater accuracy in judging distance to an object. Instead of claws, primates have fingernails.

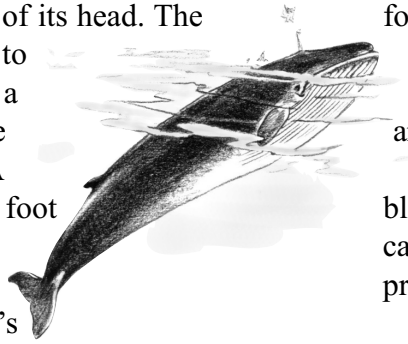
10 A mammal is put in a particular order based on such considerations as whether the mammal flies (bats), eats insects (includes moles and shrews), lives in the ocean (whales, porpoises, dolphins), has gnawing teeth (rodents), eats plants and has hooves (horses, zebras, cows, sheep, deer), has a trunk (elephants). Biologists group living mammals into about 21 different orders. Additional orders exist for extinct mammals that are not like any living orders.

11 Mammals that live their entire lives in water are ***whales***, dolphins, and porpoises. Many animals live in, on or near water. Seals, sea lions and walruses, for instance, do their hunting in water. However, they come on shore to give birth. Whales spend their entire lives in the ocean and give birth to their young there.

12 A whale gives live birth to a baby called a ***calf***. After birthing the calf, the mother whale nudges the calf to the surface where the



baby takes its first breath. Each whale breathes through an opening called a ***blowhole*** in the top of its head. The mother provides up to 160 gallons of milk a day for the calf. The milk is rich in fat. A layer of fat nearly a foot thick is known as ***blubber*** and preserves the whale's body heat in cold ocean water. Like all mammals, whales are warm-blooded. They maintain a body temperature of around 99ºF.



13 The blubber also serves two other purposes. It is a storehouse of energy. When whales migrate from the cold water of their feeding grounds to warmer waters to give birth, the animals burn some of the fat as energy. In addition, the fat is lighter than water, so the blubber helps the whale to float effortlessly in water.

VOCABULARY

Baleen: a horn or bone-like material attached to the upper jaw of baleen whales; the whale uses the baleen as a filter to catch plankton, krill and other small forms of life upon which it feeds

Rodents: compose an order of mammals such as the mouse, rat, squirrel or beaver with large front teeth (incisors) that are designed for gnawing

Incisors: sharp, front teeth designed for cutting or gnawing

Enamel: the hard outer coating of teeth

Dentine: a softer tooth material under the enamel; incisor teeth of rodents are kept sharp because the back of the teeth have exposed dentine that wears away

Canines: two long, pointed, fang-shaped teeth common to carnivores

14 Like other mammals, whales have lungs and breathe air. However, they can stay for an hour or more underwater. Whales have several features to provide oxygen to their organs while they are below water and cannot breathe air. Their blood is especially rich in red blood cells. Red blood cells have the chemical *hemoglobin* that carries oxygen. The extra red blood cells provide extra oxygen on long dives.

15 In addition, the whale's liver (being the largest organ in mammals) acts as a storage tank of oxygen-rich blood. The liver has many functions, such as helping the body to digest food, store nutrients and manufacture part of the hemoglobin molecule. The spleen also contains extra blood with oxygen. This reserve of oxygen-rich blood is called into use when the whale is away from air for a long time.

16 During a dive, the whale is designed to power down all less essential activities. The heart rate slows. Arteries partially squeeze shut to limit the flow of blood to organs whose functions can be reduced during a dive. This conserves oxygen for use by the whale's brain, sense organs that are needed for hunting, and muscles for swimming. A whale can hold its breath for an hour.

17 Biologists put whales in two categories based on how the whales feed. Toothed whales have jaws with pointed teeth. These whales hunt fish, squid, and other prey. Members of the toothed whales include dolphins, porpoises, killer whales and the great sperm whales.

18 Baleen whales are toothless. They gather food by filtering it out of the water. This type of whale includes great blue whales, gray whales and humpback whales. The structure that acts as a filter is ***baleen*****,** horn-bone-like structure resembling a fine-toothed comb that drops down from the whale's upper jaw.

19 The blue whale is the largest animal ever to inhabit the Earth, yet it feeds on tiny, shrimp-like creatures known as *krill*. Blue whales take in great gulps of water, then squirt out the water, using the baleen to filter out the krill. A blue whale can collect and eat about four tons (8,000 pounds) of krill in a day.

20 ***Rodents*** are the most numerous of mammals. About half of all mammals are rodents. Rodents include mice, rats, squirrels, chipmunks, prairie dogs, beavers, hamsters and guinea pigs.

21 The word *rodent* is from a Latin word meaning "to gnaw". The most distinctive feature of rodents are their two front teeth.



These are ***incisors***, designed for cutting. Beavers can cut down trees with their sharp teeth. Squirrels and rats can cut through the insulated wiring found in homes.

22 A rodent's teeth maintain a sharp edge because of the way they are made. In front is hard ***enamel***. In the back of the tooth is softer ***dentine***. As the rodent gnaws, the back dentine wears away so only the sharp enamel is left. The tooth actually gets sharper with use.



23 The front teeth of rodents constantly grow. Should the rodent live on soft food that does not wear down the front teeth, the rodent will gnaw on wood or some other hard substance. The rodent gnaws even when he is not looking for food to keep the teeth sharp and wear them down. If a beaver did not wear down his constantly growing teeth, his teeth would be four feet long in a year's time.

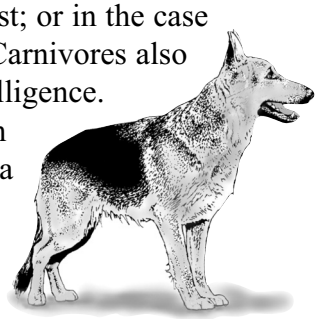
24 Rats and mice are rodents that are considered pests. They eat grains in warehouses and carry diseases. One of the most fearful and deadly diseases to strike human beings is the bubonic plague, also known as Black Death. The disease is transmitted to humans by fleas that live on rats. The bubonic plague is a threat today, but not nearly as deadly as in the 1300s in Europe. As many as one person in three died during an outbreak of the disease in Europe.



25 Rabbits are similar in many ways to rodents, but they have more gnawing teeth, so biologists put them in a separate order. Although not looked upon with as much revulsion as rats, rabbits have proven to be formidable pests. They may do more damage to human food sources than rats and mice. Rabbits attack crops and reproduce rapidly. Female rabbits can have litters of eight offspring every two months. Within two months, the young female rabbits also can birth offspring.

26 Europeans introduced rabbits into Australia in the mid-1800s. Rabbits had few natural enemies in Australia and good conditions for growth. Soon the rabbits overran the countryside, destroyed the habitat for many native species and ate the forage intended for sheep. Today, biologists estimate Australia has 500 million rabbits. Controlling rabbits in Australia continues to require a major effort.

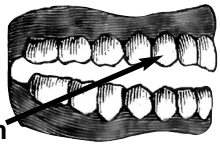
27 *Carnivores* are the order of mammals that kill and eat flesh. Carnivorous animals include the dog, wolf, fox, mink, otter, raccoon, cat, tiger, bear, and walrus. Although cats and dogs are in the same order (carnivore), they are in different families. The dog belongs to the canine family. The cat belongs to the feline family. Carnivores can pounce quickly and run fast; or in the case of the walrus, swim fast. Carnivores also have a high degree of intelligence. Sometimes they work with one another to bring down a larger animal. Wolves, for instance, hunt in packs.



28 Carnivorous animals have several characteristics that help them catch prey. Carnivores have well-developed senses: they have sharp eyes sensitive ears, and a good sense of smell.

29 Carnivores have special teeth for holding their prey. These teeth, called ***canines***, are larger than the others and are located on either side of the front teeth. The teeth are named after the Latin word for *dogs*, in which the teeth are prominent. The canine teeth are long and pointed. They project down below the other teeth and help the animal grasp its prey. Sometimes, the canine teeth are called *fangs*. In humans, teeth in a similar position are known as *eyeteeth*.





30 Two days later, Bryan and Tom packed to leave Danger Island. Del came down to Rocky Port to see them off. The dinghy from the ferry that came to pick up the boys carried Ranger Eldridge. He shook their hands and congratulated them. "You boys solved the mystery of Danger Island! Mr. Murphy had discovered a Viking ship with most of its gear in tact."

31 Bryan said, "I wish we could have rescued all of the contents looted from the Viking ship."

32 Ranger Eldridge boomed, "I have good news for you! The Coast Guard stopped and boarded the cabin cruiser. The crew recovered everything! However, the news of a complete Viking ship will not be publicized until experts have studied it."

33 "What happened to James Olsen?" Tom asked.

34 Ranger Eldridge said, "They found his rubber boat pulled up to shore at the mainland. He seemed to have vanished." Ranger Eldridge did have something special for Bryan, Tom and Del. He gave them each a videotape. He said, "It's a copy of your scene in the movie, 'Viking Quest'."

35 Tom said, "Great! Instead of my heroic actions to save the real Viking ship, my friends will see me falling face down in the mud with Del's ducks running around me. Some hero!"

36 Del looked at the boys with admiration in her eyes. "Both of you are real heroes."

Note about Danger Island: If you examine a map along the northeastern coast of North America, you will not see the island described in the Danger Island adventure. Bryan, Tom and all the other characters—and the island itself—are fictitious. However, the Vikings and their exploration along the North American continent are still subjects of much interest and debate. Although a complete Viking ship has never been found in North America, Viking ships preserved in clay as described in the Danger Island adventure have been found in Europe.



Life Principle



“Hard won victories are sweet.”

—Anonymous