SUPERCHARGED SCIENCE

Unit 18:
Biology Part 1

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Appropriate for Grades:
Grades K-8 (see notes on each lesson)
Duration: 3-25 hours, depending on how many activities you do!

Animals are all around us. As we walk through our neighborhood, we likely see animals being kept as pets, insects crawling on the ground, and birds flying through the trees. Depending on where you live, you may also see animals living in rivers, lakes, and swamps. How are these animals similar? How are they different? Why do they behave in the ways they do? How do their actions affect the environment in which they live? These are big questions that we'll be answering in the next three sections. We'll start off with a study of invertebrates - animals with no backbone. From there, we'll move to the major groups of animals with backbones - fish, amphibians, reptiles, birds, and mammals. Along the way, we'll look at how animals in each of these groups survive, interact, and impact the world.

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Materials for Experiments

Male betta fish
Fish bowl
Mirror for fish bowl
Chicken egg
Vinegar
Glass
Lizard in a terrarium (borrow one?)
Video camera
Roasted chicken
Variety of bird feathers (collected from nature)
Dead insects of your choice
Birdseed
Poster board in a variety of colors
Water bottle
2 flexible straws
Fifteen clean and empty 2-liter soda bottles with caps (check your local recycling center)
One small plastic lid that fits inside the soda bottle (like from a yogurt or butter tub)
Aluminum foil (12" piece)
Plastic vial (like an M&M container or a film canister)
1 yard (or meter) of cotton twine or rolled up paper towel
Brown paper grocery bag
Newspaper
fast-growing plant seeds (radish, grass, turnips, Chinese cabbage, moss, etc.)
Flexible or clip-on style lamp with fluorescent bulb
Soil, twigs, leaves, and organic plant material
Live predators (praying mantis or spiders or carnivorous plants)
Live red worms (about 20)
Small piece of fruit
White and black spray paint
20 feet of rope
Graph paper (optional)
Non-flexible straw
Salt
Glass
Distilled water
Permanent marker
Clay
Paint can (we'll use the lid for the secchi disk and the pail for the waterscope) OR plastic gallon-size jug
Large rubber band
Plastic film (like saran wrap)

Tools:
scissors
razor with adult help
hot glue gun
masking tape

Optional Dissection Materials:
Simple dissection tools (forceps, tweezers, scissors, scalpel, T-pins, mounting board, clear plastic ruler)
Starfish specimen
Earthworm specimen
Clam or oyster specimen
Owl Pellet

Key Vocabulary

Amniotes : Animals whose embryos are surrounded in amniotic fluid

Animal: Organisms in the kingdom Animalia.

Annilida: Invertebrate worms that have segmented bodies, such as earthworms.

Aquatic : Living in the water

Arboreal : Living in trees

Arthropoda: The phylum meaning “jointed feet;” includes four living subphyla of arthropods.

Bilateral Symmetry : Body plan in which the left and right side are mirror images.

Bipedal : walking on two legs

Body cavity: A space inside an organism used for digestion or more.

Book Lungs: Gills modified for breathing air.

Brachiation : Moving by swinging

Brackish : Slightly salty

Brood parasite : bird that lays its eggs in the nest of another bird

Camouflage : blending in with non-living things around you

Carapace: The thick dorsal shield seen in many crustaceans; often forms a protective chamber for the gills.

Carnivore : Meat-eater

Cartilage : The flexible material that makes up the human outer ear and nose, and the body of some fish

Cartilaginous Fishes : Group of fish with bodies made of cartilage instead of bone

Cell colonies: Groups of cells which work together; coral reefs, for example.

Cephalization : Having most nervous tissue concentrated in one part of the body

Class : Group of similar living things in the same phylum or sub-phylum

Classify: Group; as in grouping organisms into hierarchical categories.

Cnidaria: Invertebrates that have radial symmetry and include the jellyfish.

Complete digestive tract: A digestive tract that has two openings, the mouth and the anus.

Coral reef: Cnidarians that live on ocean reefs in colonies.

Cranium : Brain cavity

Cuticle: The outer layer of the exoskeleton.

Echinodermata: The phylum of the echinoderms; contains about 7,000 living species, the largest phylum without freshwater or terrestrial members.

Echinoderms: Organisms in the phylum Echinodermata.

Ectothermic : Having a body temperature which changes based on the outside temperature

Endoskeleton: A hard structure giving an organism shape found inside of the organism; for example, the human skeleton.

Endothermic : maintaining a constant body temperature regardless of the outside temperature

Estrus : The optimal time for females to become pregnant

Exocuticle: The thin and waxy water resistant outer layer of the cuticle.

Family: Organisms descended from the same ancestors sharing relatively similar characteristics.

Flatworm: Worms lacking a body cavity found in the phylum platyhelminthes.

Fledge : being able to fly on its own

Frugivore : fruit-eater

Gangla: A compact group of nerve cells having a specific function.

Gastric Mill: A gizzard-like structure for grinding food.

Gastrovascular cavity: A large cavity having both digestive and circulatory functions.

Generalist : animal that will eat multiple types of food

Genus: Groups of species that are structurally similar or phylogenetically related.

Gestation : time spent in the mother's womb

Guano : bird droppings

Gut: An area in an organism used for digestion.

Harem : group of females which mate with a single male

Herbivore : Plant-eater

Host : bird that has an egg in its nest from a brood parasite

Hydroskeleton: Fluid-filled body cavity that provides support for muscle contraction.

Incomplete digestive system: A digestive tract that has only one opening.

Innate Behavior : animal behavior that does not need to be learned

Insectivore : Insect-eater

Invertebrate: Animals without a backbone.

Kingdom : Large group of living things with common characteristics; the domain in which living organisms are classified.

Leydig's Organ : Organ found only in cartilaginous fishes that produces red blood cells

Locomotion : Moving

Mammary gland : gland that releases milk for adult mammals to give to their young

Marsupials : mammals that have a pouch in which the offspring lives

Medusa: Cnidarian with a bell-shaped body directed downward.

Metamorphosis : Major change in body shape and structure

Migration : Movement from one place to another

Mollusca: The phylum containing ten living classes of mollusks.

Mollusk: An invertebrate of a large phylum (Mollusca) that includes snails, slugs, mussels, and octopuses. They have a soft, unsegmented body and live in aquatic or damp habitats, and most kinds have an external calcareous shell.

Molting: The process by which arthropods shed their hard exoskeleton in order to grow.

Monogamous : breeding with only one partner per breeding season

Nematocysts: Specialized cells in cnidarians that can release a small thread-like structure and toxins to capture prey.

Nematoda: Invertebrate worms that include the roundworms.

Nerve net: Interconnected neurons that send signals in all directions.

Nymphs: A developmental stage of insects, where the young is usually similar to the adult.

Omnivore : Eating meat and plants

Opposable : able to move to touch all the finders

Order: Containing one or more families .

Oviparous: A method of reproduction where the young hatch after the eggs have been laid.

Pentadactyl : having five fingers

Pheromones: Chemicals secreted by animals, especially insects, that influence the behavior or development of others within the same species.

Phylum : Group of living things in the same kingdom with common characteristics; a principal taxonomic category that ranks above class and below kingdom.

Placental : group of mammals in which fetuses are nourished by a placenta

Placoid : Type of scale found in cartilaginous fishes made of dermal teeth

Platyhelminthes: Invertebrate worms that include the flatworms and tapeworms.

Polygamous : breeding with multiple partners per breeding season

Polyp: Cnidarian with a cup-shaped body directed upward.

Porifera: Filter-feeders with sac-like bodies; known as the sponges.

Radial symmetry: A body plan in which any cut through the center results in two identical halves.

Radula: A molluscan feeding structure, composed mostly of chitin.

Roundworm: A nematode worm (class Phasmida), esp. a parasitic one found in the intestines of mammals.

Segmentation: A body plan that has repeated units or segments.

Segmented worm: A worm composed of repeating units (segments).

Sessile filter feeder: Organisms permanently attached and not freely moving, that feed by filtering organic matter out of the water.

Sexual Dimorphism : having males and females that look very different

Species: Organisms capable of mating with one another.

Spiracles: Openings on the sides of the insect abdomen, through which air is taken in.

Sponges: Filter-feeding organisms with sac-like bodies, belonging to the phylum Porifera.

Subphylum : Group of living things in the same phylum with common characteristics

Swim Bladder : Organ in bony fishes that allows them to regulate their density

Tapeworms: Intestinal parasites in the phylum Platyhelminthes.

Terrestrial : Living on land

Tetrapod : Having four legs

Valerian Respiration : Respiration through the skin

Vertebrate : Animal with several distinguishing characteristics, including the presence of a spinal column or backbone of bone or cartilage.

Water vascular system: A network of fluid-filled canals; functions in gas exchange, feeding, and also in locomotion.

Wingless insects: Insects without wings.

Unit Description

Animals are all around us. As we walk through our neighborhood, we likely see animals being kept as pets, insects crawling on the ground, and birds flying through the trees. Depending on where you live, you may also see animals living in rivers, lakes, and swamps. How are these animals similar? How are they different? Why do they behave in the ways they do? How do their actions affect the environment in which they live?

These are big questions that we'll be answering in the next three sections. We'll start off with a study of invertebrates - animals with no backbone. From there, we'll move to the major groups of animals with backbones - fish, amphibians, reptiles, birds, and mammals. Along the way, we'll look at how animals in each of these groups survive, interact, and impact the world.

This is important because we share the world with some amazing creatures. Although there's nothing wrong with simply sitting back and admiring animals, it's even more satisfying to observe animals when you know something about them and where they fit into the world around us. Seeing how all these animals coexist is part of what makes our world such a fascinating place in which to live.

Objectives

Lesson 1: Invertebrates

This lesson covers the wonderful world of spineless creatures—invertebrates. Invertebrates are animals without backbones

There are many different types of invertebrates: from starfish to bees to worms to sea angels! Here are the different types we're going to learn about:

Sponges are colonies of specialized cells. They feed by filtering the water around them. They are bound to the ground beneath them. They have no nerves. They are held together through the cooperation of the colony.

There are two basic body forms of Cnidarians; polyp and medusa. All Cnidarians have stinging cells, called nematocysts. They all also have radial symmetry. Cnidarians are more developed than sponges; they have real tissues, a body cavity, and nerves.

Key physical differences between worms can depend on whether they possess a body cavity and/or segments. Flatworms have neither a body cavity nor segments.

Roundworms only have a body cavity, and segmented worms have both a body cavity and segments. Some worms are parasitic (the tape-worm, for example) while others are not (like the sea flatworm).

Mollusks—including mussels, scallops, and oysters—live in shallow water. The mollusk body plan generally involves a muscular foot for locomotion, a body housing organs, a head with eyes or tentacles, and a mantle (which creates the shell). Usually, they absorb oxygen from the water using gills.

Echinoderms, meaning "spiny skin", are radial symmetric marine animals. They are found at all depths—both shallow and deep water. They play important roles in their ecosystems. Despite appearances, they do not have skeletons. The "spiny skin" is, in fact, skin covering a spiny endoskeleton (internal skeleton). They have water vascular systems.

Arthropods, or organisms in the phylum arthropoda, are organisms with segmented bodies and appendages on at least one segment.

Arthropods are covered my hard external skeletons. When they grow they shed these skeletons in a process called molting.

For gas exchange aquatic arthropods have gills, while terrestrial (land-based) arthropods have either a tracheal systems or book lungs. Tracheal systems are air sacs fed by pores in the exoskeleton. Book lungs are gills modified to extract oxygen from air.

Insects are not only the most diverse subgroup of arthropods, but with over a million discovered species it is the most diverse group of animals on earth. Although they can't all be as beautiful as a butterfly, they all play important roles in their ecosystems—just think of where we would be without bees!

In biology we classify organism. By "classify" we mean that we place organisms into groups according to physical characteristics they have. These groups are hierarchical. The some groups fit inside others. We use the following groups to classify life: Kingdom, phyla, class, order, family, genus, and species. A good pneumonic for this hierarchy is **K**ings **P**lay **C**ards **O**n **F**unny **G**reen **S**tools; each first letter stands for the first letter of a group in the hierarchy. We'll learn how to classify using this system.

Objectives

Lesson 2: Fishes, Amphibians & Reptiles

In this section, you will learn what a vertebrate is. You will then learn about three groups of animals that are vertebrates : fish, amphibians, and reptiles.

You will learn basic information about many of these fascinating species, including their survival techniques, lifecycles, eating habits, and reproduction. This is important because these groups make up the majority of all vertebrate species.

We encounter these animals all the time, whether it's a fish in the ocean, a frog in a pond, or a lizard sunning itself on a rock. Learning a little more about these animals will help you appreciate them even more.

At the end of this section, you will be able to:

- Identify what makes something a vertebrate
- Distinguish the three major groups of fish
- Describe unifying characteristics of all fish
- Explain the lifecycles of amphibians
- Describe how the body structure of reptiles is suited for their lives
- Differentiate between the three major groups of reptiles
- Explain the importance of fish, amphibians, and reptiles to both humans and the ecosystems in which they live

Objectives

Lesson 3: Birds & Mammals

Birds and mammals are probably the animals you encounter the most every day. In this unit, you will have a chance to learn more about these incredible animals. We will look at what they eat, how they reproduce, the ways they care for their young, how they get around, and the role they play in the environment.

This is important because, as we mentioned, these animals are a part of our lives and knowing more about them will make us appreciate them even more when we see them.

In this unit, you will learn:

- The characteristics of a bird
- How birds care for their young
- What makes bird beaks and feet unique
- The purpose of bird migration
- The types of mammals and how they are similar and different
- Ways in which mammals care for their young
- How mammals get around
- How primates are unique amongst mammals
- How primates move and communicate

Textbook Reading

Classifying Organisms using Little Boxes

Imagine a little box of spoons. Now, imagine on moving day that that box of spoons is put into a bigger box with all of the silverware. Now, imagine that that box of silverware is placed into an even bigger box with all of the kitchen stuff.

Now, imagine that the box of kitchen stuff is placed in the moving truck with all of the stuff from your house. In the end the within the truck is all of the stuff from your house, within kitchen box are all of the things from the kitchen, and within the spoon box are just the spoons.

In the same way, we will group organisms according to their physical appearance into hierarchical categories.

In this unit we're going to discuss **invertebrates** by naming what characteristics they have, and placing them in categories accordingly. For example, jellyfish are placed in the Cnidarian category due to their radial symmetry and stinging cells. Meanwhile Cnidarians are placed in the invertebrate category due to their lack of a backbone. Furthermore, invertebrates are placed in the animal category because they are multicellular, eukaryotic[1], and heterotrophic[2]. In this way, we **classify** animals; we place them in categories according to physical characteristics[3] they have (radial symmetry, stinging cells, and lack of backbone, for example).

As you can see, the largest box or category, "animals", is much larger than the tiny category "jellyfish". The number of organisms in each category gets progressively fewer as you classify things from animals in general, to jellyfish in particular. The categories follow this structure:

Kingdom: The domain in which living organisms are classified.

Phylum: The subdivision in which all classes below have the same body plan.

[1] Having cells containing true nuclei.
[2] Required to eat molecules to survive: do not produce their own food.
[3] It is important to note that modern biology classifies organisms according to DNA similarity.

Class: Organisms that share one or more attributes.

Order: Containing one or more families.

Family: Organisms descended from the same ancestors sharing relatively similar characteristics.

Genus: Groups of species that are structurally similar or phylogenetically related.

Species: Organisms capable of mating with one another.

An easy way to remember the order of the hierarchy is to think of this pneumonic: **K**ings **P**lay **C**ards **O**n **F**unny **G**reen **S**tools—each first letter stands for the first letter of a level in the hierarchy (Kingdom, phylum, etc).

For example the classification of the jellyfish the Portuguese Man-O-War (shown):

Kingdom: Animalia (Multicellular, heterotrophic, eukaryotic)

Phylum: Cnidaria (Radial symmetry, stinging cells)

Class: Hydrozoa (very small predatory animals, mostly saltwater, solitary and colonial)

Order: Siphonophora (Colonies of specialized cells which could not survive on their own and resemble one organism)

Family: Physaliidae (Organisms of the genus *Physalia*)

Genus: *Physalia* (Colonies of specialized cells which float on the Indian or Pacific Oceans via gas-filled bladders)

Species: *P. physalis* (Portuguese Man-O-War)

Lesson 1: Invertebrates

What are invertebrates? Invertebrates are animals without backbones. This is contrasted with animals *with* backbones, or **vertebrates**.

Examples of invertebrates are jellyfish, star fish, insects, and earthworms. An example of a vertebrate is… *Us (humans)!*

Sponges and Cnidarians

Invertebrates are organisms without backbones. Let's look at two very

simple types of invertebrates; Sponges and Cnidarians.

Sponges (Phylum Porifera)

Sponges, found in oceans all over the world are made up of **colonies** of specialized cells—some help push water through the sponge, some help it feed, some are responsible for reproduction, etc. They feed by filtering water through its pores. In this sense, they are known as **sessile filter feeders**. Sponges are attached to the ground below them—they are *sessile* (unable to move).

Besides their specialized cells, sponges do not have any organs, nerves, or even true tissues. They are held together through the cooperation of the colony.

Cnidarians (Phylum Cnidaria)

Painful stinging cells, called **nematocysts**, make the phylum **Cnidaria** especially notable. Jellyfish and sea anemones are just two examples of these painful creatures. The nematocysts are, in fact, long hollow threads that are used to trap prey. Additionally, these nematocysts are triggered externally, so even if you come across a dead jellyfish don't step on it!

Cnidarians also are **radially symmetrical**. This means they have a circular body plan such that any way you cut them in half the sides will be equal.

There are two basic body forms; **polyp** and **medusa**. The polyp is a cup-shaped body—with the mouth facing upward (sea anemones, for example). The medusa is bell-shaped and has a downward-facing mouth (jellyfish, for example).

A Cnidarian with a polyp body plan, a sea anemone, and a Cnidarian with a medusa body plan, a jellyfish. Notice the upward facing mouth of the polyp, and the downward facing one of the jellyfish.

Cnidarians, *unlike sponges*, have true tissues. They digest their food in a **gastrovascular cavity**—a large cavity containing digestive enzymes. The digestive cavity also has circulatory functions.

Cnidarians, *like sponges*, can form colonies. Colonies of polyps form the jellyfish the Portuguese Man-O-War. Similarly, colonies of

cnidarians form on calcium carbonate skeletons to make **coral reefs**.

Worms

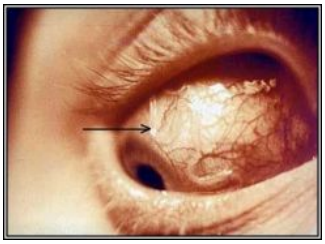
Here we're going to discuss the differences between three types of **worms**; **flatworms, roundworms,** and **segmented worms**. The word "worm" is not, in fact, a scientific name. It's an informal way of classifying animals with long bodies and no appendages (not including snakes). They are bilaterally symmetrical (the right and left sides mirror each other). Worms live in salt and fresh water, on land, and inside other organisms as parasites.

The differences between the three types of worms we will discuss depend on the possession of a **body cavity** and **segments**. Flatworms have neither a body cavity nor segments. Roundworms only have a body cavity, and segmented worms have both a body cavity and segments.

Flatworms (Phylum Platyhelminthes)

Flatworms have **incomplete digestive systems**. That means that their digestive system has only one opening. The gas exchange occurs on the surface of their bodies. There are no blood vessels or nervous systems in flatworms. Some are non-parasitic, like the Sea flat worm, and some are parasitic, like the tapeworm.

Roundworms (Phylum Nematoda)



Roundworms have body cavities—as contrasted with flatworms which do not. The body cavity allows roundworms to have **complete digestive tracts** (both a mouth and an anus). The mouth and anus are connected by a **gut**—where the food is digested. They also have a simple nervous system and brain.

Roundworms can be parasites of plants and animals. In dogs they are often know to cause heart problems. In humans roundworm parasites can sometimes cause a swelling disease called *elephantitis*.

Segmented Worms (Phylum Annalida)

Segmented worms, the most developed of the three, have both a body cavity and segments. Their body cavity helps give them structure—it serves as a **hydroskeleton.**

By "segmented" it's meant that they are divided into repeating units. They can be non-parasitic (i.e. earthworms) or parasitic (i.e. leeches). Interestingly, the giant red leech only eats giant earthworms.

Mollusks (Phylum Mollusca)

If you have ever gone searching though tide-pools at the beach, you've probably seen your fair share of **Mollusks**. This is because mollusks live mainly in the sea (in the intertidal zone), although some live in freshwater.

Mussels, scallops snails, oysters (from which we get pearls!), and clams are only a few examples of types of mollusks. The mollusk body plan generally involves a muscular foot for locomotion, a body housing organs, a head with eyes or tentacles, and a mantle (which creates the shell). Usually, they absorb oxygen from the water using gills.

Only mollusks have a structure called a **radula**. Radulae (the plural of radula) are composed mostly of chitin, and can be as simple as a structure used to scrape algae off rocks, to the beaks of octopuses.

Echinoderms (Phylum Echinodermata)

Echinoderms, meaning "spiny skin", are radial symmetric marine animals. They are found at all depths—both shallow and deep water. They play important roles in their ecosystems. Despite appearances, they do not have skeletons. The "spiny skin" is, in fact, skin covering a spiny **endoskeleton** (internal skeleton).

How do echinoderms move? How do they feed themselves?

Echinoderms have a **water vascular system** responsible for gas exchange, movement, and feeding. This system is an internal network of fluid-filled canals. Depending on the species, they have various ways of getting food

into their water vascular systems. Some are filter feeders, while others (such as starfish) are predatory. They use this system in place of gills, heart, and a closed circulatory system. Although they do not have brains, they do have **nerve nets** responsible for receiving and processing sensory information.

Echinoderms are found worldwide, and play important roles in their environments. Primarily, they are strong links in the food chain. For example, they control the growth

of algae on coral reefs (making it easier for the reefs to filter-feed), and they serve as food for other organisms (otters, for example).

Arthropods (Phylum Arthropoda)

Arthropods, or organisms in the phylum **arthropoda**, are organisms with segmented bodies and appendages on at least one segment. They use these appendages for defense, feeding, sensory perception, and locomotion. We usually see them everyday: fly on the wall, or perhaps moth by the light. The

phylum is incredibly divers and the organisms within it have developed numerous adaptations to deal with environments from your kitchen counter to the Amazon! Arthropoda is the largest phylum in the animal kingdom. Examples of Arthropods include: scorpions, crabs and crayfish.

Arthropods are covered my hard external skeletons. When they grow they shed these skeletons in a process called **molting**.

For gas exchange aquatic arthropods have **gills**, while **terrestrial** (land-based) arthropods have either a **tracheal systems** or **book lungs**. Tracheal systems are air sacs fed by pores in the exoskeleton. Book lungs are gills modified to extract oxygen from air.

Crustaceans

Six classes of **crustaceans** are recognized in the word, and almost fifty two thousand species. Most of them are aquatic. Interestingly, they have a brain in the form of **ganglia** (connections between nerve cells).

The phylum Mirapoda: Centipedes and Millipedes

Over thirteen thousand species of the phylum Myrapoda exist! All of them live on land. Some species have fewer than ten legs, while some can have over seven hundred and fifty!

Spiders and spider-like creatures: Arachnids

Spiders (a type of Arachnid) are found in the class Araneae and the subphylum **Chelicerata**. This subphylum includes scorpions, mites, and ticks as well as spiders. Arachnids characteristically have four pairs of legs, a pair of chelicerae (see table at the end of this section), and a body organized into the cephalothorax (a fusion of the head, thorax, and abdomen). There are eleven subgroups of Arachnids.

Insects

Insects are not only the most diverse subgroup of arthropods, but with over a million discovered species it is the most diverse group of animals on earth. Although they can't all be as beautiful as a butterfly, they all play important roles in their ecosystems—just

think of where we would be without bees!

The segmented exoskeletons of insects have a hard, inner layer called the **cuticle**, and a water-resistant outside layer called the **exocuticle**. Insects are divided into two major groups: **winged insects** and **wingless insects**. Air is taken in through structures called **spirials**, and delivered directly to the body.

Most insects and are **oviparous**

(hatch from eggs after the eggs are laid).

Lesson 2: Fishes, Amphibians & Reptiles

As you walk around your neighborhood, you probably see many other people, as well as some birds flying around, maybe some fish swimming down a local stream, and perhaps even a lizard darting behind a bush or a frog sitting contently on top of a pond.

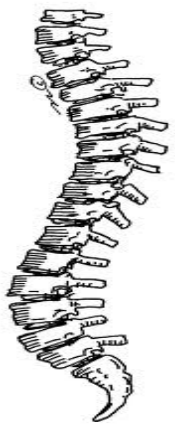
Most likely, you know that all of these living things are animals, but they are even more closely related than that.

While all animals belong to the same **kingdom**, which is a very large group of living things sharing common characteristics, all the animals described above belong to the **phylum** chordata.

Phyla (that's the plural of phylum) are groups of more closely related living things in the same kingdom. Moreover, the human being, fish, bird, lizard, and frog, all belong to a more specific group, or **subphylum**, called vertebrata.

The subphylum vertebrata are commonly called the **vertebrates.** As you might have guessed, a subphylum is a group of closely related living things in the same phylum.

Vertebrates can be identified because they have a spinal column or backbone, as well as a brain case called a **cranium**, and (with one exception) an internal skeleton.



The presence of a backbone is one of the defining features of vertebrates.

Another characteristic that unites vertebrates is **cephalization.** Cephalization means that most of the nervous tissue is in one section of the body. This leads to the development of sensory organs, most importantly eyes.

Vertebrates are hugely diverse, ranging from a tiny carp, less than a centimeter in length, to the massive 110 foot long blue whale. Vertebrates differ dramatically in their size.

Introduction to Fish

There are 57,739 species of vertebrates. The majority of these vertebrates can be classified as fish. This includes jawless species of fish and cartilaginous fishes. (Those are fish with skeletons made of cartilage, the same material that makes up your nose.)

Most fish, and more than half of vertebrate species, however, (over 30,000) are jawed, bony fish.

We know fish are **aquatic**, meaning they live in the water, but so are whales and sea snakes, and neither one of those are fish, so there certainly is more to being a fish than just that. In fact, fish tend share many important characteristics besides simply living in the water.

First, fish are almost always **ectothermic**. This means that the body temperature of fish changes based on the outside temperature.

This is different than other animals (including humans) who keep a constant body temperature no matter the temperature outside.

Additionally, fish generally lay eggs, have two paired fins, and have scales. Finally, fish typically have gills which allow them to get oxygen from water, allowing them to breathe while in their underwater habitat.

Notice that in the previous paragraph we never said that *all* fish have a certain characteristic. That's because there are plenty of exceptions to these general characteristics of fish.

Tuna, for example, have the ability to warm their bodies so that their body temperature is warmer than the cool water in which they live.

Moray eels do not have scales. Not all fish have paired fins. Even what seems to be the most "fish-like" characteristic of all, living in water, is not something that all fish have in common.

Mudskippers (image below), for example, are fish that spend a considerable amount of time on land, living for several days at a time on mudflats, where they absorb oxygen through their skin in order to breathe.

The group agnatha, also known as the jawless fish, make up one group of fishes. There are about 100 species of jawless fish, which can be placed into one of two groups – the lampreys and the hagfish. Interestingly, although

these fish do belong to the vertebrate subphylum, they do not technically have vertebrae.

In fact, this group of fish is so different than fish with jaws, it has led some scientists to wonder if they should be called "fish" at all.

Along with their lack of jaws, the jawless fish are notably different than other fish because they do not have paired fins.

Agnatha do not have an identifiable stomach, and don't have a true eye, instead having a light-sensitive eye-like structure. These fish have bodies made of cartilage and have a heart with only two chambers as opposed to the normal four.

Hagfish also produce a slimy substance which has led some people to call them "slime eels," although they are not eels at all. The Pacific Hagfish is one example of a jawless fish.

The **cartilaginous fishes** are a group of about 1,000 species separated into two groups. The first group is the sharks, rays, and skates, and the second group is the chimaera, sometimes called the ghost sharks.

These two groups share many things in common, including the presence of jaws, paired fins, a two-chambered heart, and bodies made of cartilage.

As mentioned before, cartilage is the same material that makes up the outside of your ears and nose.

One of the challenges of having bodies made of cartilage instead of having bones is that the cartilaginous fishes have no bone marrow in which to produce red blood cells. These cells are needed to carry oxygen around the body, so the cartilaginous fishes produce them in other locations, including the spleen, around the gonads, and in a special organ called **Leydig's Organ**, found only in this group.

Additionally, the cartilaginous fishes have dermal teeth, also known as **placoid** scales. These scales give the bodies of the cartilaginous fishes a rough, sandpaper-like feel.

This white fin shark, like all sharks, have bodies made of cartilage rather than bone.

By far the largest group of fish are the bony fish. Eight species of bony fish make up a small group called lobe-finned fish, including the lungfish, a fish with the ability to breathe air, that can even drown if it is kept in water too long.

Another 27,000 species make up the ray-finned fish. Remember from above that there are a total of slightly less than 58,000 species of all vertebrates. It is clear that bony, ray-finned fish are the most common vertebrates.

The lungfish is one of only eight species of lobe-finned bony fish.

As with fish in general, bony fish vary greatly in size and weight, from the 3.3 meter (11 foot) ocean sunfish, topping the scales at over 5,000 pounds, to the tiny pygmy goby, a mere 1.5 cm (0.6 in).

In spite of the variation in size and weight, bony fish have several characteristics that group them together and make them unique amongst the fish.

First, these fish have the ability to regenerate bone from cartilage inside their body. Additionally, ray-finned fish are the only fish that can see in color.

Finally, all members of this group have **swim bladders**, which they are able to add oxygen to or remove oxygen from. This allows the fish to control its density.

Why would a fish want to do this? As you may know, things that are more dense than the fluid they are in will sink, while things less dense than the fluid will float. By changing their density compared to the fluid they are in (water), a fish can cause itself to rise up higher or sink down lower as needed.

There are a number of reasons why fish are important to humans. They provide a source of food, especially for people who live in areas near water. Fishing is also a popular recreational activity, and many people enjoy viewing these beautiful animals in aquariums every day.

Fish are important to more than just humans however. The food web of the oceans and lakes of the

world are some of the most diverse on the planet, and the wide variety of fish that live in these ecosystems play a crucial role in maintaining a balance. Humans have recognized this, and have begun to restrict fishing and recreational activities in areas where too much human activity could be harmful to the aquatic ecosystem.

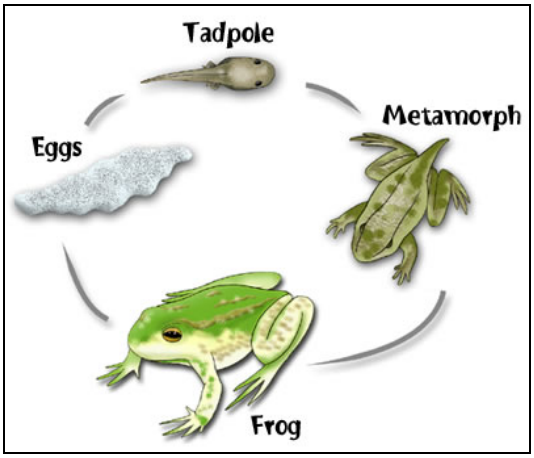
Introduction to Amphibians

About 6,000 species of animals belong to the class amphibia, commonly called the amphibians. A **class** is a group of living things in the same phylum or sub-phylum (in this case, vertebrata) that share certain characteristics.

In the case of the amphibians, one of the most important characteristics they share is that they begin life in the water, but then spend most of their lives on land.

Although amphibians inhabit many environments, from tropical to arctic climates, they cannot live in saltwater, eliminating the oceans as a place to find these animals. Some amphibians do live in **brackish** water, which is slightly salty, but these animals generally live in or near freshwater. Amphibians are ectothermic and carnivorous, generally feeding on bugs and other arthropods.

The life cycle of amphibians is one of the most interesting of the vertebrates. Adult animals lay a shell-less egg, usually in a pond or some other freshwater location. A larva then hatches. The legless larva lives in the water, breathing through gills, as fish do. Slowly, over time, the larva undergoes a **metamorphosis**, or change in body structure. During this change, the larva takes on the adult form, losing its gills, growing four legs, and eventually becoming completely **terrestrial**, meaning that it lives only on land.



The lifecycle of the frog, in which the larva is called a tadpole, is typical of amphibians.

As part of becoming terrestrial, amphibians must undergo several

changes. Their gills are replaced with another respiratory organ, like lungs, allowing them to breathe on land. Their skin also undergoes a change to keep them from losing water and becoming dehydrated. They develop eyelids to more effectively see in a terrestrial environment. Finally, an eardrum develops separating the exterior from the middle ear.

About 500 amphibian species are salamanders. These animals are generally characterized by tails, short legs, and moist skin. The moist skin of the salamander requires them to live in or near water more than many other amphibians. In fact, some salamanders live their whole lives in water. Others live outside water in the adult stage, but stay in swamps, where the ground is moist, and will not dehydrate their skin.

The Eastern Mud Salamander is found throughout eastern North America.

Salamanders are unique in both their respiration and feeding. Some salamanders have lungs and breathe in a way similar to mammals. Others keep their gills into adulthood, and remain in the water, breathing through their gills. Still others have neither gills nor lungs, and breathe through **valerian respiration** in which air is passed through the skin. In terms of hunting, a muscle called the hyoid muscle shoots out, along with the tongue. The tongue of the salamander is covered in mucus, and prey is captured in this sticky mucus. Salamanders are also the only vertebrate that can regenerate lost limbs.

Frogs and toads are members of the same **order**, which is a group of similar living things in the same class. People sometimes distinguish frogs and toads based on the fact that toads usually live in drier environments, and have leathery skin to help them in this environment.

However, there is really very little difference between animals referred to as “frogs” and “toads” in this reading, other than the fact that toads do not have any teeth and must swallow their food whole. To make things simpler in this reading, we will just call this group of animals “frogs.”

Frogs can be characterized by long legs and the absence of a tail. They spend their adulthood out of the water, breathing through lungs. Frogs enter the water in the adult stage only to reproduce.

Frogs have elongated ankle bones, and with their long legs, they are usually excellent jumpers. These amphibians also tend to have weak connective tissue, giving their skin a leathery, warty appearance. They also have three eyelids, including a transparent eyelid specifically for protecting the eye while in the larval stage, known in frogs as the tadpole stage. The other eyelids act as the eyelids do for many other terrestrial animals.

Frogs (believe it or not) are seen as delicacies in many parts of the world, and are used as a source of food. They have also figured prominently in stories and folklore. The word salamander comes from the word for "fire" because of the fact that these amphibians often live in old logs, and would come out when there was a fire. This led some people to believe the fire was creating the salamanders. Scientists view amphibians as excellent indicators of the health of an ecosystem because they are generally are in the middle of the food web. Finally, amphibians have been considered a "model organism" for study in the laboratory because their larval forms can be fairly easily manipulated and they generally reproduce quickly.

Introduction to Reptiles

Reptiles don't have the best reputation. Whether it's a poisonous snake or a vicious crocodile, many people think of these animals in negative terms. As we will see, much of the reputation is undeserved, based on misunderstandings of these animals. Indeed, reptiles fill an important part of the ecosystems in which they live.

Reptiles are spread out widely, living on every continent except Antarctica. These vertebrates are characterized by breathing air, being ectothermic, being **tetrapods** (having four legs), and being **amniotes** (meaning that their embryos are surrounded in amniotic fluid). Most reptiles lay eggs, although some give birth to live young. In all cases, the birth process is more similar to mammals than it is to amphibians or fish in terms of both the nourishment and care that parents give the offspring.

Lizards and snakes make up the largest order of the reptiles. Although we often think of them

differently, snakes are basically legless lizards, from a biological perspective.

Reptiles in this group are characterized by having scales or shields on their body and by having a lower jawbone that can be moved independently from the braincase.

This allows snakes and lizards to open their mouths very wide, a trait that is especially noticeable when snakes, which also have a very flexible jaw, are eating relatively large food, as you can see below:

This snake is able to eat an egg whole by moving its very flexible jaw.

Besides the obvious lack of legs, snakes are distinguished from lizard by the lack of external ears. Snakes are all **carnivorous**, meaning they eat meat of other animals. Snakes frequently eat rodents, insects, eggs, and even other snakes. Almost all snakes lay eggs, and they generally abandon the eggs shortly after laying them.

The somewhat unusual body structure of snakes leads to some unusual characteristics. As was mentioned above, snakes have very flexible jaws. This helps make up for the fact that they cannot use limbs to grasp prey, like most animals do. Also, because their bodies are so long and narrow, if a snake has two of a certain organ, such as the kidney, they are found one in front of the other as opposed to side by side.

Only a small minority of snakes have venom. Of those that do, venom is usually used to immobilize and begin to digest prey, rather than as a means of self-defense. Nevertheless, snake bites can be both painful and dangerous, so it is always best to steer clear of snakes (as well as most other animals) in the wild. Snakes without venom usually kill prey by constricting, or wrapping their bodies around the prey and squeezing tightly.

Lizards can generally be characterized by having four legs, movable eyelids, and external ears. Some lizards do not have legs, or have legs that are so small they are basically useless. These reptiles can still be distinguished

from snakes because of their external ears. Most lizards are **insectivores**, meaning they eat insects. Most lizards lay eggs, although some give birth to live young.

Like most lizards, the Eastern Fence Lizard has four legs and external ears.

Many lizards have excellent vision, including having the ability to see in color, and they communicate with each other using bright colors and body language. Lizards also use **pheromones**, or body scents, as a method of communication.

Many lizards can regenerate their tail, and will release their tail to escape a predator. Other methods for escaping predators including climbing and running, both of which lizards do very well. Some lizards even have the ability to run on only two legs.

Alligators and crocodiles are closely related, and are both in the group crocodilia. This group, is considered closely related to birds. The crocodile body allows it to spread its legs and move close to the ground (the belly walk) or bring its legs in and move more upright (the high walk).

The Nile Crocodile shows the basic crocodile body plan.

Crocodiles have a number of similarities to mammals. Unlike any other reptile, but like mammals, crocodiles have a four chambered heart. They are also similar to mammals in that they have **thecodont dentition.** This means that their teeth are in bony sockets. However, their teeth and heart differ from mammals in important ways too. Crocodiles have the ability to regenerate their teeth throughout their lives. Also, blood with and without oxygen mix in crocodiles, something that never happens in a healthy mammal.

Whether a crocodile is male or female is not determined genetically, as it is in most

animals. Instead, it is based on environmental factors. The temperature surrounding an egg shortly after it is laid determines if a male or female crocodile will hatch.

Crocodiles are well-suited for a hot, aquatic environment. By holding their mouths open, a process known as gaping, crocodiles cool off. Additionally, crocodiles can breathe underwater. A set of internal nostrils in the crocodile's throat, are closed off by the tongue when the crocodile goes underwater, allowing it to breathe.

There are about 500 species of turtles, many of which are highly endangered. Turtles are characterized by having a large, protective shell made of bone or cartilage, which comes from their ribs. Although many turtles live in or near water, they lay their eggs on land. Turtles also must come up to the surface to breathe through their lungs.

The shell of this Eastern Box Turtle comes from its ribs.

Turtles have excellent vision, allowing them to see well at night and see in color. Turtles living on land generally have eyes that point down, allowing them to see what is right in front of them. Sea turtles have eyes higher up. This allows them to hide them from predators, completely submerged except for their eyes and nostrils. Sea turtles can also cry salty tears, allowing them to rid themselves of some of the salt in the water they are in.

Turtles do not have teeth. Instead they have ridges in their jaw. In carnivorous turtles, these ridges are sharp enough to rip apart prey. **Herbivorous** turtles, or turtles that eat plants, have ridges designed for grinding and tearing through tough plants.

Like most reptiles, turtles lay leathery eggs. As we saw with crocodiles, some species of turtles have environmentally-determined gender in offspring. Remember that this meant that the temperature early in the embryo's fertilization determined if the offspring would be male or female.

Reptiles help humans in many ways. Snakes and lizards prey on many pests, from insects to rodents. Having these reptiles around keeps the number of pests down, reducing disease. Snake venom has also been used in the

production of medicines. Many reptiles make excellent pets. Finally, as with the other animals we have studied, reptiles frequently make appearances in stories and folklore, although this is usually in a negative context.

The vertebrates are a highly diverse group of animals, united by the presence of a spinal cord or column. Fish, amphibians, and reptiles have some traits in common, but also have important differences. Frequently, these differences help the animals to be uniquely suited to their environment. All these animals are important to humans, and to the other living things in their ecosystem.

Lesson 3: Birds and Mammals

It seems pretty easy to identify a bird. When you hear the word bird, you probably think of an animal soaring gracefully through the sky. It is true that birds have lightweight skeletons and feathers, allowing many of them to fly. Nevertheless, from small hummingbirds and jays, to large ostriches and eagles, the variety of birds is staggering. The 10,000 species in this group live in many different places on all seven continents, with the greatest variation in the tropics. They often differ rather dramatically in appearance.

With all the diversity amongst this group of animals, what makes a bird a bird? First off, birds are **endothermic vertebrates**. Being endothermic means that they keep a constant body temperature whether the temperature outside is hot or cold. Being vertebrates means that birds have backbones made of bones called **vertebrae**. All birds are also **bipedal**, meaning they walk on two legs. Birds also have feathers, and beaks with no teeth.

Finally, this group of animals is united by the fact that they all produce offspring by laying eggs.

Although not all birds can fly, and although some non-birds are able to do so, flight is probably the characteristic people most associate with birds. The bird body is lightweight, making it highly suitable for flight, and the body

contains cavities filled with air. These cavities connect to the respiratory system of birds, and give them an even lighter weight body for flight.

Birds also have wings, which make flight possible. The wing is important for both lift and thrust. In other words, the wing helps the bird get off the ground (lift) and move forward (thrust.) If you think about different type of wings, you can see that birds use their wings differently.

A larger wing, like that of an eagle or hawk, can be spread out. This provides enough lift to allow the bird to soar without using much energy. On the other hand, the small wing of a sparrow or blue jay will need to be flapped more to create the thrust needed to keep the bird off the ground. Although this is an effective way of flying, it requires more energy than soaring.

You certainly already know that birds lay eggs. Bird eggs are often a certain color so they will blend in with their surroundings. This is an example of **camouflage**, or looking like some non-living thing around you, in order to avoid predators.

Eggs are usually found in nests. Most bird nests are very elaborate, although some birds, such as the albatross, simply lay their eggs in a scrape in the ground and others, including the common guillemot, do not lay eggs in nests at all.

About 100 species, including the cuckoos, are **brood parasites**. These birds lay their eggs in the nests of other birds, referred to as the **host**. When the parasite bird is born, the host parent will care for it, even though it may hurt their own offspring. Some parasites even have shorter incubation times that hosts, so that the parasite will hatch first, destroy the eggs of the host, and ensure that it gets the most resources from the host parent.

The process of building a nest is not something birds need to be taught. Nest building is an **innate behavior,** or instinct, which means that the animal, (in this case a bird) was born knowing how to do it. Certain actions involved in caring for the nest are also innate.

For example, if a goose egg rolls out of the nest, the goose will roll it back in.

Generally, animals have instincts because they help them survive. However there can be problems with innate behaviors. In the case of geese mentioned above, the goose will roll anything that *looks* like an egg into the nest. There have been examples of geese rolling golf balls into their nests. Although this may seem silly, the reality is that spending time and energy in this activity takes away from time and energy that should be spent caring for the goose's actual eggs.

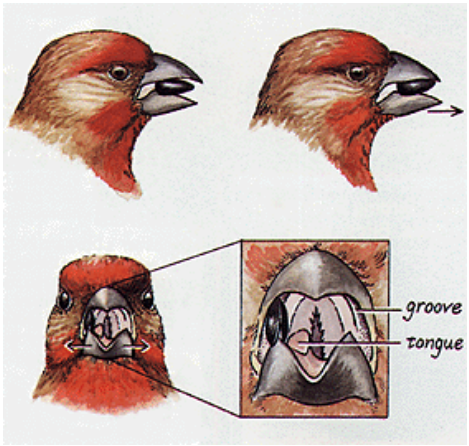
Parents incubate the eggs by sitting on nests. In 95% of bird species, males and females are **monogamous**. This means that the male and female bird remain together for the breeding season, and sometimes even year after year, until one mate dies. In such species, the male and female share responsibility for incubating the young. In **polygamous** species, where birds have multiple mating partners during the breeding season, one parent does all the incubation.

Baby birds exhibit innate behavior that helps them survive. Babies will naturally open their mouths when they believe they are going to be fed.

Parental care varies greatly between species. Parents usually care for the young until they **fledge**, or are about to fledge, meaning that they learn how to fly, but there are exceptions. The offspring of the murrelet follow their parents out to sea immediately after they are born to avoid being eaten by predators on land. Some birds, including the magapodes, do not care for their young at all. The young birds dig their own way out of the nest and begin to care for themselves right away. On the other extreme is the Great Frigatebird. Like many seabirds, this species cares for their young extensively. Young frigatebirds take six months to fledge. After this, the parent continues to feed their offspring for another 14 months. No other species cares for young for this length of time.

One defining characteristic of birds is the presence of a beak. The many different types of beaks reflect the fact that birds eat many different things.

Some are **carnivores**, feeding on meat, others are **insectivores**, eating insects, while still others are **generalists** who will eat a variety of foods. Parrots have curved hooked bills, which are ideal for cracking nuts and seeds, while the hooded warbler has a longer beak with bristles around it, designed to sense and eat insects. One of the most distinct beaks is the long, tubed beak of the hummingbird, ideal for getting nectar from flower.



The beak of the finch (left) and warbler (right) are designed for different diets.

Just like birds have different types of beaks based on where they live and what they eat, they also have feet suited to their lifestyle.

When you think of special feet, the first thing that comes to mind might be the webbed feet of ducks, terns, and other waterfowl.

Along with webbed feet, some birds, including herons, gallinules and rails have four long spreading toes. This type of toe is used for walking delicately in the wetlands in which they live. Carnivorous birds often have sharp claws needed for grasping their prey.

The four toes (shown above) on the foot of a heron are well-suited for life in the wetlands.

Many birds **migrate** from one place to another. Often times, birds living in the North will travel

South to the tropics when the weather becomes too cold. Birds use natural landmarks such as riverbeds, or look at the direction of the sun to assist them in their migration patterns. By doing this, birds ensure that they follow the same path every year.

Birds migrate South, in order to find warmer weather.

Birds are useful to human beings in a number of ways. Some, such as turkeys and chickens are a food source. **Guano**, which are bird droppings, are used as a fertilizer, both in a manufactured state and naturally as birds lay their droppings on the areas above which they fly. Bird watching or listening to birds sing provides a source of recreation and fun for many people.

Chickens can serve as an early warning system for diseases such as West Nile Virus. Mosquitoes bite young chickens, infecting them with the disease. Usually, about three months later, an outbreak will start in humans. By examining the sick birds, public health officials can prepare for humans to be struck by the disease in advance.

Birds also help plants. Some birds, such as hummingbirds, pollinate plants by spreading pollen when they drink plants' nectar. **Frugivores**, which are birds that eat fruit, help to spread seeds, since they often fly to a different location to eat the fruit they got from a plant. This helps ensure that plants are spread out, and less likely to compete with each other for limited resources, as they would if they were all in the same place.

Introduction to Mammals

Mammals are endothermic vertebrates. They have many characteristics in common, including the presence of hair, the presence of sweat glands, and the presence of three middle ear bones. They also have a four-chambered heart and specialized teeth for ripping, tearing, and chewing foods. Finally, mammals have a gland called a **mammary** gland. This gland produces milk, which adults provide for their offspring.

One small group of relatively primitive mammals are known as the **monotremes**. These animals share several characteristics with birds and reptiles. Along with having only one body opening for urinating, defecating, and reproduction, the monotremes reproduce by laying eggs, something no other mammals do.

The leathery eggs of monotremes are similar to those laid by lizards

and crocodiles. Like all mammals, monotremes provide milk to their offsrpring, however these animals lack the nipples present on other mammals, so milk is released by the sweat glands. Monotremes include the spiny anteater and the platypus.

All other mammals can be classified as either marsupial or placental. Both of these groups of mammals are viviparous, meaning they give birth to live young. **Marsupials** are characterized by the presence of a pouch in the female. The pouch contains the mammary glands, which nourish the young. The offspring of marsupials remain in the pouch until they are able to survive on their own. The most well known marsupials are probably kangaroos and koalas, but there are a number of other marsupials, many from Australia.

The majority of mammals are **placental** mammals. These mammals have a placenta, which provides nourishment and removes waste while the fetus is in the mother's womb.

Some mammals remain solitary except when reproducing. This mammals will interact with each other only when the female is in **estrus.** Other mammals live in large groups, often with one dominant male. This male will mate with all the females in the group, which are referred to as a **harem**. Sea lions are one group of mammals known for living in large harems.

Mammals can be placed into groups in many different ways. We have already seen that method of reproduction can be used to group mammals into monotrems, marsupials, and placentals. Since the placental group is so large, it is often helpful to break it up even further.

Within the placental group, animals are often separated

based on what they eat. As was mentioned earlier, carnivores, such as dogs, cats, and bears, eat meat. The sharp teeth seen in these animals are useful in ripping and tearing food. Insectivores, such as shrews and moles, eat insects. Other groups of mammals include the lagomorphs, a group including hares and rabbits, rodents, which include mice and rats, and the ungulates, or hoofed animals, such as giraffes, elephants, goats, and pigs. These animals are generally **herbivores,** or plant eaters, and have large flat teeth good for grinding tough plant material. A final group of mammals includes the bats and primates. This is the group in which humans are found.

Another method for grouping mammals focuses on the environment in which they live, and their method of **locomotion**, or movement, in their environment. Animals, including mammals, that live on land are called **terrestrial.** Within terrestrial mammals, several methods of locomotion exist. Many marsupials and lagomorphs have developed **saltatory** locomotion**,** or leaping, as method for getting from place to place. Dogs, horses, and deer all move by running. Elephants, hippopotamuses, rhinoceroses, use **graviportal** locomotion, in which they lumber along on very thick legs.

Not all mammals live on land. **Aquatic** mammals, such as dolphins, whales, and manatees, live in the water. These mammals have fins and tails where other mammals have arms and legs. Other mammals, including many monkeys, are **arboreal,** meaning they live mainly or exclusively in trees. For these animals long arms and a strong tail assist with swinging as a locomotion method. Still other mammals, such as bats and some primates, have wings for flying or gliding.

In these cases of locomotion, and in the description of teeth described above, a basic idea of biology, referred to as “form follows function,” is seen.

Basically, this idea means that the way something looks on an animal (its form) is based on what it does (the function.) Monkeys have long arms to swing from trees, whales have fins to swim through the ocean, and bats have wings to fly. In each case, the animal is a placental mammal, but the limb on the animal is well-suited for the environment in which they live and the way they get around.

It is likely that you run into many mammals (other than people) every day. Mammals such as dogs, cats, and some rodents are kept as pets. Mammals like cows and pigs are raised for food. In some places, mammals such as horses, elephants, and camels are used for transportation.

People take advantage of the intelligence of mammals in a number of ways. Dogs perform a variety of jobs including service dogs for the blind and other people with disabilities. Dolphins have been used to rescue lost divers and locate underwater mines. Mice and rats are used in maze-running experiments to test human memory, and by studying the way mammals learn, scientists have been able to discover more about human learning.

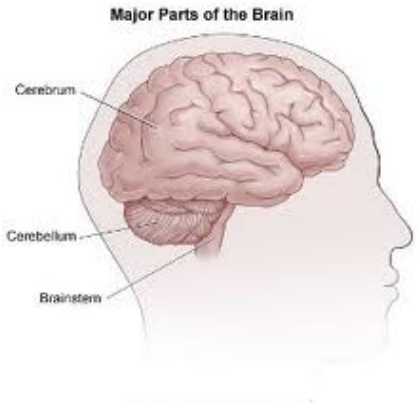
Mammals also play important roles in the ecology of the areas in which they live. Some bats drink nectar, giving them an important role in the pollination of plants. Fruit eating mammals help spread seeds when they move to a new location to eat.

Introduction to Primates

Primates are a group of mammals which includes human beings. Primates are related to either lemurs, monkeys, or apes. These mammals have a number of characteristics that make them unique. First, all primates are **pentadactyl**, meaning they have five fingers. One of these fingers, the thumb, is **opposable,** allowing it to touch the other four fingers. This is very helpful in grasping things. Primates also have a bone running around the eye sockets called a post-occipital bar.

The brains of primates are also different than the brains of other mammals. All mammal brains have three parts – the cerebrum,

cerebellum, and brainstem. In primates, the size of the cerebrum is larger in comparison to the other two parts. Since the cerebrum controls things including thinking, learning, and language, it is thought that this larger cerebrum explains the high intelligence of primates, even compared to other mammals. Primates show their intelligence in their ability to learn and have social interaction, including playing and fighting.



Primates can be divided into three groups, monkeys, prosimians, and the apes. Prosimians include lemurs and animals closely related to lemurs. These animals live in Madagascar, an island off the coast of Africa, and a group of islands in the Indian Ocean. Monkeys and apes (except humans) are found in Africa and in the Americas.

Apes and old world monkeys tend to have **sexual dimorphism**, meaning that the males and females are very different sizes. Males are about twice as large as

females. This may be because males are polygamous, and try to attract as many females as possible. Some monkeys are monogamous, and the males and females work together to raise their offspring are about the same size.

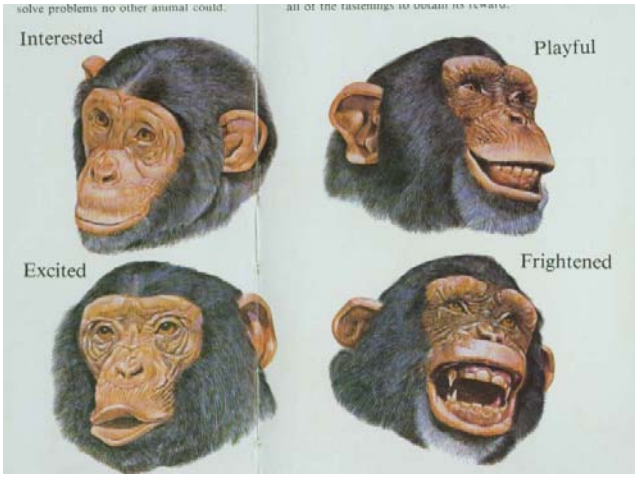
Unlike other animals that typically have a large number of offspring at once, primates tend to only have one baby at a time. They also have a fairly long **gestation** time, or time that the offspring spends in the mother's womb. The advantage to this is that the baby is born more advanced, and thus more likely to survive.

Many primates are arboreal, and most of those primates who are not completely arboreal spend at least some of their time in trees. Very few species are able to live completely on land. Arboreal primates have many characteristics that make them suited for life in trees. With their opposable

thumbs and long fingers and arms, they are excellent at **brachiation**, or swinging from tree to tree.

Primates tend to be **omnivores**, which means that they will eat both meat and plants. As you might expect, primate teeth are somewhere in between the sharp teeth of carnivores and the flat teeth of herbivores. Although they will eat anything, most primates prefer fruit as a food if it is available.

Many animals communicate using sound (think of birds using mating calls) or smell, primates use sight as a main communication tool. Primates can express emotion that can be understood by other members of their species based on a look on their face. As humans who use facial expressions, we may take something like this for granted, but it makes primates nearly unique in the animal kingdom.



Although most primate species are **quadripedal,** meaning they walk on four legs, the arms of primates are used for many things, including gathering food and nesting material. In some primates, arms are used for making and holding tools. For example, gorillas use sticks to gauge the depth of water, and chimpanzees sharpen sticks to use as weapons in hunting, and use stones like a hammer to break things apart.

"Fishing" for termites with a stick is an example of using tools seen in primates.

Birds and mammals, the two endothermic groups of animals, show a remarkable amount of diversity. These animals have found ways to survive in nearly every environment on the planet, eating a wide variety of foods and moving from place to place in a number of ways. Although their reproductive strategies vary, they are characterized by, for the most part, caring for their young more than many other kinds of animals. As mammals ourselves, we can see many familiar characteristics in these animals.

Activities and Experiments

Lesson 1: Invertebrates

Activity: *Build your own worm farm and watch them turn food scraps into soil!*

Materials:

- 2 polystyrene boxes with lids the same size. Let's call them Bin A and Bin B.
- A sheet of insect screen to fit the bottom of the boxes
- Newspaper clippings
- Garden soil
- Food scraps (half-eaten fruits and veggies, stale biscuits and cakes, crushed egg shells, coffee grounds)
- Water
- 1000 Worms (Either "Tiger", "reds", or "blues"; ask for them at your local garden store)

Build the farm:

1. Punch evenly spaced holes in the bottom of Bin A.
2. Place the insect screen on the bottom of Bin A (this is so that the worms don't fall out).
3. Fill Bin A ¾ full with wet newspaper clippings.
4. Add a layer of garden soil to Bin A.
5. Add the worms.
6. Place Bin A in Bin B. Make sure there's enough room in Bin B when Bin A's placed in it to collect the worm pee and waste. Be sure to empty and clean Bin B every couple days.
7. Add food to bin A! Start off small. You don't want to over-feed the worms. Start out with a couple scraps in the corner and see how long it takes for them to disappear—that should give you a good idea of how much to feed your worms.

Activity: *Invertebrate Journal!*

The key to good scientific research is a good scientific journal. Here are some pointers for starting a real scientific journal, and some activities once you have it:

Materials:

- Notebook with blank pages (spiral-bound composition notebooks work great)
- Invertebrates (earthworms, crickets, ants, etc. They can usually be found at your local petstore).

What to do:

1. At the top of each page mark the date, and location. 12: 30, San Francisco, for example.
2. Next write a quick sentence about what you will be doing or observing. For Example “today three phyla of invertebrates will be observed, and compared.”
3. Draw! Draw a picture of what you’re looking at. If you’re looking at earthworms, sketch one out. All of the great biologist drew pictures of the things they studied.
4. Make some observations. What are the differences between the cricket and the worm you’re looking at, for example? What’s the same? Can you make a simple table showing what’s similar and different?
5. Make some conclusions. “Worms and Crickets are related but not as closely as worms and leeches.”
6. Sign the study—make it official!
7. Try to do this every day for a week.

Activity: *Worm Comparison*

Materials:

- Earthworms
- Mealworms
- Magnifying glass
- Containers for worms
- Pencils and paper

Compare:

1. Look at the worms under the magnifying glass.
2. Measure the lengths of the worms.
3. Make note of:
    a. The outer layer of the worms.
        i. Is it hard? Is it segmented?
        ii. What are other observations that can be made?
    b. Do they have legs? Do they have antenna?
    c. What are the main differences? What are the main similarities?

Activity: *Squid Races*

Make squids out of balloons and straws and then race them! This fun, simple activity demonstrates the may in which squids move!

Materials:

- Balloons
- Markers
- fishing line or string.
- drinking straws
- tape
- paper clips
- misc. cardboard, paper, plastic and other scraps of material
- stopwatches
- metric ruler or tape measure optional for math extension
- graph paper

Build them:

1. Blow up two balloons of your choice but instead of tying it, twist the ends of the balloons around a small paper clip to keep the air from escaping until the race begins.

2. Tape a short piece of drinking-straw to the top of the balloons. This will be how you attach the squids to the racetrack.

3. Decorate! Tape body features you want your squid to have onto the balloons (fins, stabilizers, tentacles, etc). Keep in mind that the open end of the balloon will be the rear of the squid!

4. Create the race-track! Stretch two strings or fishing lines across the room so that they are taunt. These are going to be the tracks the squids race on. For example, you could use two chairs to stretch the string across the room.

5. Attach each squid to the racetrack by running a string through the drinking straw and under the track. Tie the string with a knot so the balloon doesn't fly away.

5. When ready, release the paper clips and let the squids travel down the string. Time the travel, then use a ruler and record the total distance travelled.

Discussion:

A. What is the propulsion system on a squid?

B. What caused the squid balloon to move forward?

C. Consider the balloon that won the race. What body modifications gave this squid the winning edge?

D. Draw a diagram of a squid and label its body parts.

E. How do the actual squid body features compare to those of the winning balloon?

Extension:

F. Calculate the speed of each squid using the time and distance. (Speed = distance/time)

G. Make a bar graph comparing the speed of each squid in the class.

E. What can we learn from this graph?

Activities and Experiments

Lesson 2: Fishes, Amphibians & Reptiles

Activity: *Mirror, Mirror, on The Wall*

When you look in a mirror, you recognize that what you see is your reflection. Not all animals realize this. Many animals think the animal they see is another member of their species, and react with either fear or a show or bravado to defend to defend their territory. Let's examine the reaction of the standard betta.

1. Obtain a male betta, and place it alone in a bowl.
2. Place a mirror in the bowl.
3. When the betta sees his reflection, record his response.

What's happening: Most male bettas will respond by showing all of their fins, a behavior known as flaring, designed to make the fish look large, and protect their territory. When mirrors have been left in bowls, males have become so obsessed with flaring they have even forgotten to eat and died, so take the mirror out as soon as the experiment is over! In the animal kingdom, only primates have been shown to generally understand that they are looking at themselves in the mirror. Amongst humans, babies under 10 months of age generally don't understand this concept. If your betta did not react by flaring, see if you can think of why. Is the fish used to living with others and not very territorial? This is the trouble with only testing one animal. There are usually other factors involved.

Activity: *Frog Songs*

You'll need to travel to a pond where frogs can be found in order to do this activity. But if you think talking to frogs (and having them talk back) sounds fun, it'll be worth it.

1. Get familiar with the sounds frogs in your area by doing some research into your area's frogs.
2. Travel to a pond with frogs in the evening. As you quietly walk up, listen to the sound that the frogs are making.
3. When you get to the pond, the frogs will probably go silent, fearing that you are a predator.

4. Blow up a balloon and start rubbing the side with your finger. This sounds like the call of many frogs.
5. See if you can have a "conversation" with a frog.

What's Happening: Frogs are amphibians, so they spend the first part of their life in water. They live on the land as adults, but must return to the water to reproduce. Male frogs "sing" to alert females to their presence and encourage them to come into the water to reproduce.

Activity: *Frog Egg Hunt*

Once frogs lay eggs, they are generally fairly easy to spot in and around the swamps and marshes in which they live. Each frog egg starts out as a tiny dark spot surrounded by a thick layer of clear jelly-like stuff. The jelly acts kind of like a shell that protects the egg. Most frogs' eggs form clumps. This activity will work around April, when frogs lay their eggs.

1. Visit a local pond or swamp and seek out some frogs. Listen for frog sounds and see if you can identify the type of frog.
2. Once you've found frogs, look for eggs.
3. Once you've found some eggs, make some observations. Are the eggs floating at the surface or under the water? Are they attached to plants or not? If they form a clump, is it small or large?
4. Come back again in a week or so. How do the eggs look different?

What's Happening: Over time, the eggs will become larger and take on the shape of the larva (tadpole, that will eventually be hatched from it.

Activity: *Reptile Eggs*

The type of egg you probably have the most familiarity with are chicken eggs. Reptiles, like chickens and other birds, lay eggs. However, reptile eggs are different in appearance and texture than chicken eggs, being more leathery than smooth.

1. Place a chicken egg in a jar.
2. Cover the egg with vinegar and cover the jar.
3. Place the jar in the refrigerator and wait several days.
4. Remove the lid feel the egg making observations about texture.

What's Happening: Vinegar is made of an acid called acetic acid. This acid breaks down the calcium in the egg, making its texture very similar to the

leathery texture of reptile eggs. It is important to realize that reptile eggs do not have their texture because of vinegar. Using vinegar is just a helpful way to simulate these types of eggs.

Activity: *Side of the Strike*

Your brain is divided into two sides, sometimes called hemispheres. Through experiments, scientists have determined that each side is responsible for different things. For example, the left side of the brain is mainly responsible for language, while the right side is in charge of spatial perception. Also, each side of the brain controls the action of the opposite side of the body. Humans are not the only animals with different hemispheres controlling different actions. This experiment will explore if feeding in lizards is controlled mainly by one side of the body, and if lizards feed mainly to one side.

1. Obtain a lizard in a terrarium (can you borrow one?)
2. Set up a video camera to record the lizard for several days.
3. Place live crickets in the terrarium for the lizard to eat. Watch the lizard eat a few to get an idea of what the strike looks like, but the since you are capturing the action on video, you don't need to sit there all day.
4. Watch the video of each cricket capture. If possible watch in slow motion.
5. Cover the monitor on which you are watching the strikes with clear plastic wrap, and draw a line from the center of the lizard prior to the strike (right between the eyes) to the point of capture. Be careful that nothing you are doing will damage your monitor.
6. Do this for all the strikes. (Twenty would be a good number to get some reliable data, but realize that will make this experiment take some time, as lizards take a while to eat 20 crickets.)
7. Once you have all your lines drawn, count the number of times the lizard struck to the left, struck to the right, or went straight ahead. Record your results.

What's Happening: Remember that each side of the brain controls the opposite side of the body. You can determine with side of the lizard's brain is more responsible for predation (eating) based on which side it strikes on more often. This will vary from lizard to lizard.

Activities and Experiments

Lesson 3: Birds & Mammals

Activity: *Chicken Dissection*

By completing a dissection, you can see firsthand the anatomy of an animal. Dissecting a roasted chicken (yes, the same kind that you eat) will allow you to investigate the skin, muscle, and bones of this bird. So, if you're interested in seeing what allows a chicken to run, fly, and survive, go out to the grocery store and grab some chicken!

1. Observe a roasted chicken. Make note of the skin. The skin provides the chicken with protection, just like it does in human beings.
2. Note: The next steps require a knife and scissors. Be sure to get parent permission before doing this. Now, with a knike, cut the skin from the back to the front along the sternum bone, which you should be able to feel along the top of the chicken.
3. Pull the skin back to expose the muscle (the part you eat).
4. With a fork or with your fingers, remove the muscle. Notice the amount of muscle present and the fact that it connects to the sternum, or breastbone. This muscle also attaches to the wing, and provides the wing with the muscle it needs for flight.
5. Remove a leg from the whole chicken. Cut the skin to expose muscle. Pull muscle out from the top half of the leg. The single bone you see is the femur. As you look at the top of the bone, notice the circular looking structure. This is part of the ball-and-socket joint that connects the femur and hip.
6. Carefully remove the muscle from the lower half of the leg, exposing the larger tibia and smaller fibula bones. Also notice that there is quite a bit of muscle attached to the leg. Remember that chickens run more than they fly.

Why is this important: By looking at the muscle and bones of the chicken, you can learn a great deal about the animal. It is clear that both flight and running are important for chickens. It is also interesting to note the ways in which chicken anatomy is similar to human anatomy. Both animals have sternums, a femur, a tibia, and a fibula. If you'd like, you can dissect the

wing in the same way as the leg, and observe the same bones as the human arm.

Activity: *Go on a Feather Hunt*

Having feathers is one of the most distinct features of birds. In fact, birds are the only living group of animals that have feathers. Not all feathers are the same however. Take a walk, find some feathers, and explore what they do!

1. Find an area where birds are common. Go for a walk and collect as many feathers from the ground as many as you can.
2. Classify the feathers into groups as shown below:
    a. Wing Feathers – These feathers will be firm and strong and have a hollow tube. The tube is light because it's hollow, but also strong. Wing feathers have more feather on one side of the tube than the other. The side with more feather faces the body, so you can determine if the feather was on the left or right side
    b. Tail Feathers – These feathers will be as strong as wing feathers, with the same hollow tube going down the center. Unlike wing feathers, however, these feathers will have equal amounts of feather on both sides of the tube
    c. Body Feathers – These feathers will not be as strong wing or tail feathers. They will be more flexible and colorful.
    d. Down Feathers – These will be the softest, most flexible feathers of all.

What's Happening: Each feather looks different because it has a different purpose. Wing and tail feathers assist in flying and gliding. Body feathers give the bird color, which can help them in blending in for camouflage or standing out to attract a mate. Down feathers provide insulation. They are under the body feathers and keep heat in or out depending on the weather.

Activity: *Birds and Colors*

Birds respond to colors in different ways. Some colors make birds want to come closer (attracts them) while other colors make birds want to stay away (repels them.) Create a hypothesis about which colors birds prefer. Then get set to do some bird watching to find out.

1. Go to an area (it could be your backyard or a nearby park) where you see many birds.

2. Set up posters in a variety of colors, each with some birdseed in front of it to attract birds.
3. Spend some time watching the area and see which colors birds tend to go to, and if there is a difference between species.
4. Record your results

What's Happening: Birds respond to color based on their lifestyles. For example, hummingbirds are attracted to red and yellow because these are the colors of the flowers from which they drink nectar.

Activity: *Birdfeeder Science*

Some birds only eat one type of food. Some will eat several types of food, but most do have a preference. Given the choice of insects or seeds, which do you think most birds would select? Your answer to this question is called a hypothesis. You can test your hypothesis with a simple experiment.

1. Set up two containers – one with insects and one with birdseed. You can try several types of insects (in different experiments) typically available at pet shops.
2. Set up a video camera to record birds that come to visit your bird feeder. Try to get as long a video as possible.
3. Watch the video, and observe how many birds eat insects and how many eat seeds. Also observe what the birds that eat each type of food look like. Depending on the area in which you live, you may have long periods without birds, which is why watching on video, when you can fast forward, is a better idea than sitting and watching your birdfeeder.
4. Record which type of food was more popular. Also see if you can identify the birds you attracted. Were there certain species that liked one type of food over the other?

What's Happening: Your results will depend largely on what birds live in the area where you live. Hopefully, you will be able to find and identify both insect- and seed-eating birds.

Activity: *A Dog's Life*

Want to study an animal but don't feel like going outside? If you have dogs as pets, you have built-in subjects. Good experiments have one variable, or change. So, you might want to get two dogs that are the same age but different breeds. Or perhaps two dogs of the same breed but different ages.

Even just a male versus female dog could work. Just make sure they have only *one* difference. Comparing an old male great dane to a female poodle puppy is no good. If your dogs won't make good test subjects, ask friends and family.

1. Think of a behavior your dog does naturally, like eating, barking, or going to the bathroom. You can even think of a behavior your dog has learned, like doing a trick or catching a Frisbee.
2. Make a hypothesis about how the two dogs will do these activities differently. Possible questions could be:
    a. Do different breeds of dogs eat at different speeds?
    b. Do young dogs bark more than old dogs?
    c. Are female dogs able to learn more tricks than male dogs.
3. Design an experiment and test your results.

What's Happening: Your results will give you information about the dogs you tested, but you must avoid the temptation of thinking all dogs react the same as the ones in your study. I once had a cocker spaniel that was afraid of pillow. Does this mean all cocker spaniels are afraid of pillows? Of course not! But if we let one dog from one experiment represent the entire breed, these are the kinds of conclusions we get. If this was a true experiment, we'd need to get hundreds, if not thousands of dogs involved. Still, this is a good first step in getting an idea about this behavior.

Exercises

Invertebrates Exercises

1. What is the difference between invertebrates and vertebrates?
2. Are sponges colonies of cells? If so, are all the cells the same type?
3. What are sessile filter feeders?
4. Would you want to touch an organism with nematocysts? Why or why not?
5. What is the difference between a polyp and a medusa?
6. What are two differences between sponges and Cnidarians?
7. Name two examples of Cnidarian colonies.
8. What are some of the differences between flatworms, roundworms, and segmented worms?
9. What is an incomplete digestive system?
10. Which part of a segmented worm serves as its hydroskeleton?
11. Which invertebrate has a radula, and what is it used for?
12. Do Echinoderms have exoskeletons?
13. Give two examples of Echinoderms.
14. What role doe nerve nets play in Echinoderms?
15. Which phylum molts its exoskeleton in order to grow?
16. What are three examples of arthropods?
17. Do arthropods only use book lungs to breath?
18. What are the two major groups of insects?
19. How do most insects reproduce?

Exercises

Fishes, Amphibians & Reptiles Exercises

1. What trait do all vertebrates share?
2. How is a phylum related to a kingdom?
3. What is agnatha more commonly known as?
4. What are sharks bodies made of instead of bone?
5. What does the swim bladder do in bony fish?
6. What happens if an object is less dense than the fluid around it?
7. How do amphibians breathe in the larval stage?
8. What is a metamorphosis?
9. What effect does the loose connective tissue of toads have on their appearance?
10. Why were salamanders associated with fire?
11. Why do snakes need very flexible jaws?
12. How are the kidneys of snakes different than other animals?
13. How are the ears of snakes different than lizards?
14. How are the hearts of crocodiles different than the hearts of other reptiles?
15. What is the purpose of gaping in crocodiles?
16. How are crocodiles able to stay submerged in water for a long time?
17. What is the shell made from in turtles?
18. Describe the vision of turtles.
19. How do turtles stay in water to avoid predators?
20. What are two ways reptiles are helpful to people?

Exercises

Birds & Mammals Exercises

1. What does it mean when we say an animal is endothermic?
2. What are three things about birds' bodies that make them well-designed for flight?
3. Why doesn't an eagle need to flap its wings as much as a sparrow?
4. How do the color of bird eggs help them avoid being eaten by predators?
5. Why is it beneficial for a brood parasite to have a shorter incubation time than its host?
6. How does incubation differ in monogamous and polygamous species?
7. What is the significance of fledging for the parental care of most species of birds?
8. What explains the differences in beaks amongst different types of birds?
9. Describe the feet of birds living in the wetlands.
10. How do birds keep the same migration pattern every year?
11. How can chickens be early predictors of West Nile Virus?
12. What is the purpose of mammary glands in mammals?
13. What group of mammals lay eggs?
14. What does the placenta do?
15. What is true of all the animals in the ungulate group?
16. How are the teeth of carnivores different than herbivores?
17. What is meant by the idea "form follows function?"
18. What are two ways that mammals help people?
19. What does it mean to have an opposable thumb?
20. What is the main method of communication in primates?

Answers to Exercises

Answers to Invertebrates Exercises

1. What is the difference between invertebrates and vertebrates? Vertebrates are animals with backbones while invertebrates do not have a backbone.
2. Are sponges colonies of cells? If so, are all the cells the same type? Yes, sponges are colonies of cells. No, they are not all the same type—they are specialized to perform different functions such as filter food, and attach the sponge to the ocean bottom.
3. What are sessile filter feeders? Organisms, such as sponges, which filter their food out of the water, and are attached to the substrate beneath them—they do not move.
4. Would you want to touch an organism with nematocysts? Why or why not? No way! Nematocysts are the stinging cells found on Cnidarians!
5. What is the difference between a polyp and a medusa? A polyp has an upward facing mouth while medusa's mouths face downward.
6. What are two differences between sponges and Cnidarians? Cnidarians have real tissue, and have a body cavity.
7. Name two examples of Cnidarian colonies. Coral reefs and Portuguese Men-O-War.
8. What are some of the differences between flatworms, roundworms, and segmented worms? Flatworms have neither a body cavity nor segments. Roundworms only have a body cavity, and segmented worms have both a body cavity and segments.
9. What is an incomplete digestive system? It is a digestive system with only one opening—a mouth.
10. Which part of a segmented worm serves as its hydroskeleton? Its body cavity.
11. Which invertebrate has a radula, and what is it used for? Mollusks have radula, and it is used for feeding.
12. Do Echinoderms have exoskeletons? No, they have endoskeletons.
13. Give two examples of Echinoderms. Starfish, sea urchin, sea cucumber, etc.
14. What role doe nerve nets play in Echinoderms? They act as a type of brain—receiving and processing information.

15. Which phylum molts its exoskeleton in order to grow? Arthropoda.
16. What are three examples of arthropods? Crabs, lobsters, scorpions, spiders, mites, ticks, etc.
17. Do arthropods only use book lungs to breath? No, aquatic arthropods use gills and some terrestrial arthropods use tracheal systems.
18. What are the two major groups of insects? Winged insects, and wingless insects.
19. How do insects breathe? Through structures called spirials.
20. How do most insects reproduce? Through sexual reproduction that results in eggs (oviparous).

Answers to Exercises

Answers to Fishes, Amphibians & Reptiles Exercises

1. What trait do all vertebrates share? The presence of a spinal cord or column
2. How is a phylum related to a kingdom? A phylum is a group of living things within a kingdom that have something in common
3. What is agnatha more commonly known as? The jawless fish
4. What are sharks bodies made of instead of bone? Cartilage
5. What does the swim bladder do in bony fish? Allow the fish to control its density
6. What happens if an object is less dense than the fluid around it? It will float up
7. How do amphibians breathe in the larval stage? Through gills while living underwater
8. What is a metamorphosis? A major change in body structure and appearance
9. What effect does the loose connective tissue of toads have on their appearance? It makes them appear leathery and warty
10. Why were salamanders associated with fire? They live inside logs and would come out if there was a fire
11. Why do snakes need very flexible jaws? They have no limbs to grasp prey, so they have to use their flexible jaw to swallow things whole
12. How are the kidneys of snakes different than other animals? They are one in front of the other instead of side by side
13. How are the ears of snakes different than lizards? They have an external ear present
14. How are the hearts of crocodiles different than the hearts of other reptiles? It has four chambers
15. What is the purpose of gaping in crocodiles? To cool off
16. How are crocodiles able to stay submerged in water for a long time? They are able to close off their nostrils
17. What is the shell made from in turtles? Its ribs

18. Describe the vision of turtles. They have excellent night vision and can see in color
19. How do turtles stay in water to avoid predators? They can stay submerged except for the nostrils and eyes
20. What are two ways reptiles are helpful to people? They eat pests, make good pets, and are used in the making of medicines

Answers to Exercises

Answers to Birds & Mammals Exercises

1. What does it mean when we say an animal is endothermic? The animal maintains the same body temperature inside regardless on the temperature outside.
2. What are three things about birds' bodies that make them well-designed for flight? They have lightweight bones, have cavities filled with air, and have wings
3. Why doesn't an eagle need to flap its wings as much as a sparrow? The longer wingspan of the eagle allows it to glide.
4. How do the color of bird eggs help them avoid being eaten by predators? When eggs are camouflaged, predators are less likely to see them.
5. Why is it beneficial for a brood parasite to have a shorter incubation time than its host? If the parasite is born first, the host will care for it at the expense of its own offspring.
6. How does incubation differ in monogamous and polygamous species? In polygamous species, one sex usually does the incubation alone. In monogamous species, the responsibility is shared.
7. What is the significance of fledging for the parental care of most species of birds? Parental care usually ends once the bird has fledged
8. What explains the differences in beaks amongst different types of birds? Different beaks are designed for eating different types of foods.
9. Describe the feet of birds living in the wetlands. These feet tend to be long with space between the toes.
10. How do birds keep the same migration pattern every year? Birds remember key natural landmarks or follow the path of the sun.
11. How can chickens be early predictors of West Nile Virus? Chickens tend to get the disease before humans, so they can let officials know that a human outbreak is coming.
12. What is the purpose of mammary glands in mammals? To provide milk for offspring.
13. What group of mammals lay eggs? The monotremes
14. What does the placenta do? Provides nourishment for the fetus and eliminates toxins and the fetus develops

15. What is true of all the animals in the ungulate group? They have hoofed feet
16. How are the teeth of carnivores different than herbivores? Carnivore teeth tend to be sharp, while herbivore teeth have flat tops.
17. What is meant by the idea “form follows function?” Parts of an animal look a certain way base on what they are used for.
18. What are two ways that mammals help people? Possible answers include bomb and drug-sniffing dogs, guide dogs, dolphins assisting divers and locating mines, or animals used for food and transportation.
19. What does it mean to have an opposable thumb? Opposable thumbs can touch the other four fingers.
20. What is the main method of communication in primates? Primates communicate mainly visually.

