Lesson One
Classification

Content Summary

And students think organizing their rooms is a challenge… In this introductory lesson, students learn how Aristotle and Linnaeus influenced our modern and ever-evolving system for classifying all things living.

Pacing

This video lesson should take about 45 minutes to complete, depending upon the degree of student interactivity. Additional time is required for the Reading, Writing and Thinking Activities; the Video Quiz; and the Hands-on Activity.

Lesson Materials

- *Fresh Science* Biodiversity and Classification DVD
- Lesson 1 ACTIViewer™ recording sheets (Pages 27-30); one copy per student
- "Classification" Reading, Writing and Thinking Activities (Pages 17-23); one copy each per student
- "Classifying Animals (Part 1)" Hands-on Activity (Pages 24-26); one copy per student
- Materials for Hands-on Activity (please see "Before You Begin" on Page 15)

Key Concepts

The following concepts are featured in **bold** in this lesson and appear in the DVD's Illustrated Glossary.

Aristotle
characteristic
class
classification
form
structure
taxonomy
family
genus
kingdom
Kingdom Animalia
Kingdom Fungi
Kingdom Monera
Kingdom Plantae
Kingdom Protista
Kingdom Protoctista
order
phylum
species

Student Objectives

- **Develop a rationale for a system of classification**
- **Explain that organisms are classified into hierarchical groups based on similarities in form, internal structure and chemical processes.**
- **Describe Aristotle's early work on classifying natural things and identify similarities to our modern classification system**
- **Describe Linnaeus' work and compare the present-day classification system to Linnaeus' system**
- **Construct a mnemonic device to aide in the recall of hierarchical classification groups**
- **Define a living thing as needing food for energy, having an orderly structure, and being able to respond and adapt to its environment**
- **Describe the modern, widely accepted five-kingdom classification system**

Appetizer

*[**Activity Alert!** If you plan on doing the hands-on activity (Pages 24-26), be sure to have each student bring four to six animal photos to the next science class. Explain that the photos will be used to complete an activity on animal classification. Encourage students to be creative in choosing the animals, and discourage duplicates... you don't want "Sally" bringing in six photos of her pet cat. On the other hand, it's okay if there's overlap from student to student.]*

CLASSIFICATION (T)

The National Council for Accreditation of Teacher Education (NCATE) defines the word *diversity* as "differences among groups of people and individuals based on ethnicity, race, socioeconomic status, gender, exceptionalities, language, religion, sexual orientation and geographical area." No need to panic, though… within the context of this science lesson, diversity, by adding the prefix *bio-*, has a very different meaning. That said, it's probably a good idea to find out from students what the word *biodiversity* means to them. Then, once their thoughts are revealed, you can, together, construct a definition for the word that is agreed on and understandable to all. PLAY

BIODIVERSITY AND CLASSIFICATION (T)

Please begin by reminding students that they're about to study biodiversity and classification. Distribute copies of the "Classification" ACTIViewer recording sheets to students. Explain that the sheets will prompt their note taking throughout the video lesson. Then, ask students to take a few minutes to write on their recording sheets what the words *biodiversity* and *classification* mean to them. Once students are finished writing their ideas, call on volunteers to read aloud their definitions of biodiversity. Write their key words or phrases on the board.

Next, tell students that the Thorndike·Barnhart Student Dictionary defines the word *diversity* as "complete difference or unlikeness" between objects or things. Tell them that the United States Forestry Service defines biodiversity as "the distribution and abundance of different kinds of plant and animal species and communities in a specified area." And, finally, explain that the Environmental Protection Agency has a similar definition for biodiversity as being "the number and variety of different species detected through monitoring in a given area." It's amazing how the prefix *bio-* can modify the definition of the word *diversity*.

Next, focus on the word *classification*. It is hoped students have a reasonably unified and correct definition of that word. To find out, call on student volunteers to read their definitions to the class. Again, write key words and phrases on the board. Tell students

that the Merriam-Webster Dictionary defines classification as "systematic arrangement in groups or categories according to established criteria." Translation: **classification** *(IG L1)* is the action or process of classifying; and classifying, in this case, means "arranging things (anything) or putting things into groups, or *classes*, according to shared characteristics." Be sure students know that a **characteristic** *(IG L1)* is a distinct feature that helps to identify a living thing or object.

Then, focus on the word *class* for a moment. To students, does "class" simply mean a group of students? If so, let them know that **class** *(IG L1)* also can mean a group of persons or things that are alike in some way. The Latin word *classis* means "collection." Ask students to consider how they all are alike in some way to end up in the same class (there's that word again) at school. Most likely, they're all about the same age, and therefore in the same class.

Anyway, time to get started teaching about biodiversity and classification. Sum up with students that, within the context of this lesson, biodiversity encompasses the many and varied species of living things on Earth, and classification refers to the action of arranging those species into groups according to shared characteristics. Phew!

Assure students that learning about biodiversity and classification will be far more exciting than dissecting the meanings of those two words. But that was an important first step in the process, because now students should have a clear understanding of what they will be studying. PLAY

"FUN WITH CLASSIFYING" (T)

Tell students that before they tackle real-world classification, they're going to construct a simple classification system based on characteristics they determine. In other words, it's time for them to have some fun with classifying.

Explain to students that, through this activity, they are going to have a chance to invent their own classification schemes for a group of 20 seemingly unrelated things. In doing so, they will experience some of the same thought processes people have gone through as they classify living things in our world.

To get students started, first have them consider some widely accepted classification systems with which they're familiar. For example, ask students how videos are organized in a rental store. What categories, or classes, are designated most commonly? You might list their responses on the board before advancing to the next image. PLAY

VIDEO RENTAL STORE LAYOUT (I/D)

[New releases, action-adventure, comedy, horror, children, drama aisles labeled]

How did students do in naming the main categories? Do they agree with these almost universal categories? Would they change or add any?

Again, you might want to list their responses on the board before advancing to the next image. PLAY

GROCERY STORE LAYOUT (I/D)

[Meats, dairy, produce, frozen foods, canned goods, cereal, rice and beans, baking supplies, breads, pets, paper goods aisles labeled]

No surprise, here… right? By now, students are very familiar with how food and other items typically are arranged and organized in stores. Indeed, they most likely take such organization for granted (don't we all?). When classifying makes good sense, it's rarely given a second thought.

Okay, now the fun begins… Tell students you are going to show them 20 common items. The challenge is for students to classify those items into groups that make sense to them.They will need to defend their reasons for forming the groups as they did. In terms of criteria, anything goes—size, color, shape, purpose, composition, weight—whatever students deem as useful properties by which to sort the items. PLAY ▶

VARIOUS HOUSEHOLD ITEMS; UNSORTED (P)

[Tennis ball, eraser, rubber band, paper clip, wood ruler, flashlight, glue stick, bandage, light bulb, glasses, yellow note pad, lollipop, scissors, toy airplane, spoon, battery, pencil, screwdriver, stuffed cat toy, green highlighter marker shown]

Give students several minutes to review and analyze the items. To show students an item in greater detail, FIRST PRESS PLAY or ENTER, then use the arrow keys to move about the screen; the cursor will jump from item to item. When you've reached the one you want to enlarge, simply press the ENTER or SELECT button on your remote control unit; a close-up view of the item will appear. To return to the group picture, click on the ENTER or SELECT button on the remote control unit.

Once students have had a chance to study the items, have them take a few minutes to write how they would arrange the items into groups. They might draw a simple classification chart, if time permits. Encourage students to think of sensible criteria as they consider what items could belong together. Stress that there is no "right" answer, but let them know that the more people they can get to endorse their classification scheme, the better. Then, spend a few more minutes having students present their ideas to the class. In conclusion, you might have students vote on which scheme they liked best, giving reasons for their choices.

Then, to continue the lesson, use the arrow keys to move to the return arrow button in the lower right corner of the screen. Tell students that you're going to show them a couple of other ways the items might be sorted. ◀ RETURN

VARIOUS HOUSEHOLD ITEMS; ARRANGEMENT 1 (P)

[Tennis ball, eraser, rubber band, paper clip, wood ruler, flashlight, glue stick, bandage, light bulb, glasses, yellow note pad, lollipop, scissors, toy airplane, spoon, battery, pencil, screwdriver, stuffed cat toy, green highlighter marker sorted]

Have students analyze how the items have been sorted. Can students figure out why the items were sorted into the groups shown here? Ask students to surmise what criteria the sorter must have used when establishing the groups. *[Sorted groups include: green items (highlighter and scissors); glass items (bulb and glasses); yellow items (tennis ball, flashlight, pencil and note pad); things you put in your mouth (spoon and lollipop); wood/metal items (ruler and screwdriver); silver items (battery and paper clip); rubber items (eraser and rubber band); toys (stuffed cat and toy airplane); things that stick (bandage, glue stick)]*. Did anyone in the class come up with similar groupings?

Now, show students one final scheme for classifying the items. PLAY

VARIOUS HOUSEHOLD ITEMS; ARRANGEMENT 2 (P)

[Tennis ball, eraser, rubber band, paper clip, wood ruler, flashlight, glue stick, bandage, light bulb, glasses, yellow note pad, lollipop, scissors, toy airplane, spoon, battery, pencil, screwdriver, stuffed cat toy, green highlighter marker sorted]

Can students figure out the criteria used to make these two groups? *[Things that contain metal and things that don't]* Ask students if this classification scheme makes any more sense than any other. Why or why not? When might this classification scheme make sense? *[When you're working with magnets, perhaps?]*

Explain to students that they're now ready to take their analytical skills and apply them to the classification of living things in our world. As they learn about the history of classification, it is hoped students will appreciate what scientists have experienced in their efforts to make sense and order out of the thousands of different organisms that inhabit Earth.

Let the following narrative help steer your discussion with the students. Those of you who are unfamiliar with or uncomfortable with the subject matter might want to stick fairly closely to the prepared script—paraphrasing it and customizing it to fit your particular teaching style. The visuals on the DVD are ordered based on the lesson plan, so all you need to do is watch for video and print cues telling you when to advance the DVD.

Those of you who are well versed in the subject matter can use these visuals to support your own lessons. If you prefer to use the visuals only, though, you might want to visit the Visuals a la Carte section of the DVD to help you navigate more easily through the images.

Regardless of how you choose to use the materials we've provided, remember that above all, *you* are guiding this lesson, it is not guiding you. Move through it at a pace that's comfortable for you and your students. Encourage questions and interactivity. If you're unsure of answers, have students further research their questions on the internet. Or e-mail the question to **Questions@FreshScience.com**. We're eager to help you succeed. PLAY

Main Course

A VERY, VERY BRIEF HISTORY OF CLASSIFICATION (T)

Knowing how many people feel about history, this particular story is going to be extremely short. But, it's quite necessary, because you need to know that developing a classification scheme for all the living things on Earth isn't something that happened in a day, or a week, or a year, or even a century. Think about it… you spent about five minutes classifying 20 different things; many of you had different ideas about how to group the items, resulting in a variety of classification schemes.

Now, think about undertaking the enormous challenge of classifying life on Earth. Millions of species of animals, plants, fungi and microorganisms are alive today. And, even though different species might not resemble one another in outward appearance, their similarities and relationships to one another become apparent from analyses of their internal structures and chemical processes. There is compelling evidence that the totality of living things are related by descent from common ancestors. This conclusion has been drawn after hundreds of years of studying life forms, and after advances in technology have helped scientists make observations not possible even 20 years ago.

So how to group all these living things? That's the question that was pondered more than 2,300 years ago by the Greek scientist and philosopher, **Aristotle** *(IG L1)*. Who can tell me what a philosopher is? *[Accept all reasonable definitions; answer follows.]* In this case, a philosopher is a wise person who is a teacher, or a student, or merely a lover of knowledge. A philosopher studies the truths and principles of the universe. A philosopher asks, "How do we know what we know?" or "What is the meaning of life?" Philosophers are thoughtful people. Some say a philosopher might even contemplate his or her own navel… PLAY

ARISTOTLE CONTEMPLATING A BUST OF HOMER; PAINTING (P)

But enough on that… Actually, it was about 367 B.C., when Aristotle was a mere 17 years old (or thereabouts), that he began his groundbreaking and historic scientific observations and writings. In 350 B.C., Aristotle published his epic work, "The History of Animals."

Now this was no lightweight paper that Aristotle slapped together. While doing his research, Aristotle studied more than 500 animals, dissecting about 50 of them to make detailed observations of their inner makeup. Aristotle found it useful to compare and contrast living things. He was quite taken with the idea of trying to make order and sense out of the animal kingdom. And many of his observations and conclusions are still sensible

and realistic today. Here are a few brief passages from "The History of Animals," precisely as written by Aristotle, and now faithfully translated more than 2,000 years later. PLAY

KOI (P)

"Differences are manifested in modes of subsistence, in habits, in actions performed. For instance, some animals live in water and others on land. And of those that live in water, some do so in one way, and some in another; that is to say, some live and feed in the water, take in and emit water, and cannot live if deprived of water, as is the case with the great majority of fishes." PLAY

CROCODILES (P)

"Others get their food and spend their days in the water, but do not take in water but air, nor do they bring forth in the water. Many of these creatures are furnished with feet, as the otter, the beaver and the crocodile." PLAY

WOOD DUCK DRAKE AND DUCKLINGS (P)

"Some are furnished with wings, as the diver and the grebe." PLAY

FROG (P)

"Of creatures that live in the water, some live in the sea, some in rivers, some in lakes, and some in marshes, as the frog and the newt." PLAY

SNAKE (P)

"An animal that is blooded and capable of movement on dry land, but is naturally unprovided with feet, belongs to the serpent genus."

Okay, nobody said Aristotle's writings were lively and engaging… but, they were chock full of accurate observations, many of which have withstood the test of time. PLAY

WING DETAIL OF THE WESTERN TANAGER; BAT WINGS; BUTTERFLY WINGS (P)

Ultimately, Aristotle did a lot to identify distinguishing characteristics of animals… he noted the differences in the wings of a bird compared to those of a bat or an insect. PLAY

SPHYNX CAT LOOKING AT GOLDFISH IN A BOWL (P)

He distinguished between animals with lungs and those with gills. PLAY

BARNACLES (P)

And he observed that stationary animals, like these barnacles, could be found in water, but not on dry land.

Aristotle stopped short of creating definitive groups based on his many observations. He did lump together certain animals, like those that lived on land versus those living in water, but he seemed more interested in pointing out the differences among species rather than focusing on their similarities. Also, Aristotle worked mainly with animals and plants. And, as we all know, there's more to life on Earth than animals and plants… far more.

Nonetheless, Aristotle went a long way in pioneering the attempt to classify living things. PLAY

CAROLUS LINNAEUS PORTRAIT (P)

Fast forward 2,000 years, to the 1700s, when the efforts of this fellow, a Swedish naturalist named Carl Linnaeus, helped advance the classification cause even further. You may know him by the Latin form of his name, Carolus Linnaeus. Or, you may know him as Carl von Linné, a name he took when he was knighted for his work in classification.

Linnaeus often is referred to as the "father of modern taxonomy." Can you define the word taxonomy? *[Accept all reasonable definitions; answer follows.]* PLAY

TAXONOMY (I/D)

Taxonomy *(IG L1)* is a classification system for organisms in which they are grouped by similarity of **form** *(IG L1)* , meaning outer shape, **structure** *(IG L1)* , meaning the arrangement of parts in an organism, common ancestry, or by other relationships. The word *taxonomy* comes from the Greek *taxis*, meaning "arrangement" and *nomos*, meaning "law." The Linnaean system of taxonomy organizes living things into hierarchical (or rank-ordered) groups, called taxa. The singular form of taxa is taxon. In a taxon, animals or plants are related to one another in a natural way.

Now, don't get concerned that this is getting complicated… everything will become crystal clear as we learn more about Linnaeus' system, so let's continue. PLAY

CAROLUS LINNAEUS DRESSED FOR FIELD RESEARCH (P)

Linnaeus was described as a naturalist, but his true passion was botany. Even as a child, he maintained a garden. When Linnaeus was 20, he attended school to study medicine and natural history. To help pay his way, Linnaeus gave lectures in botany, which furthered his interest in plants.

By the age of 25, Linnaeus was taking months-long trips to study distant animals, vegetation, minerals and cultures. Here he is, all decked out for one of his expeditions into the field. Linnaeus collected, brought back and catalogued hundreds of insect, mineral, plant and seed samples. He even attempted to grow the seeds of medicinal herbs and teas in his native Sweden. If you're familiar with Sweden's climate and geography, you know that growing conditions there are rather limited. But that didn't discourage Linnaeus, who had full responsibility for the famed Uppsala University Botanical Garden by the time he was 34 years old. PLAY

UPPSALA UNIVERSITY BOTANICAL GARDEN CIRCA 1745 (P)

Here's how that garden looked during Linnaeus' tenure in the mid 1740s.

Linnaeus' enthusiasm over plants was contagious, and he inspired many colleagues and students to bring plants back to him when they traveled abroad. Over time, Linnaeus amassed thousands of different plant species.

That was great… just six years earlier, when Linnaeus was 28 years old, he had published his first work on classification, *Systema Naturae*, a name that essentially means "the order of nature." In it, he presented his version of how living things should be classified and identified scientifically. PLAY

LINNAEUS' THREE-KINGDOM CLASSIFICATION MODEL (I/D)

Linnaeus organized the natural world into three main groups, or **kingdoms** *(IG L1)*—the animal kingdom, the plant kingdom and… oddly, the mineral kingdom, or as he called it, the kingdom of stones.

Guess how many pages were in the first edition of *Systema Naturae*? *[Allow speculation; answer follows.]* According to Uppsala University, the first edition, printed in 1735, had just 11 pages. So, that's why it was a good thing that he had so many dedicated followers of his efforts bringing and sending him new species. By the time the 13th edition of *Systema Naturae* was published in 1770, it consisted of 3,000 pages, and catalogued more than 10,000 species of animals and plants! PLAY

UPPSALA UNIVERSITY BOTANICAL GARDEN TODAY (P)

Linnaeus put many of the new plant species given to him into the Uppsala University Botanical Garden. And here's Linnaeus' garden as it appears today. All the plant species in the garden were cultivated by Linnaeus more than 200 years ago. PLAY

LINNAEAN HIERARCHICAL TAXONOMY (I/D)

Now, back to Linnaean classification. What Linnaeus did so brilliantly was to be the first to consistently use a binomial (meaning "two-word") scientific naming system to label each living thing. This standard is still in use today.

In *Systema Naturae*, Linnaeus also was the first to standardize hierarchical taxonomy. He grouped living things based on shared physical characteristics. Living things within kingdoms, the highest taxonomic level, were divided further into classes; classes were divided further into **orders** *(IG L1)*, orders were divided into **families** *(IG L1)*; families into genera. Do you know the word *genera*? You probably do, but you may not recognize it as the plural form of the word **genus** *(IG L1)*. Lastly, genera were divided into **species** *(IG L1)*. And by the way, *species* is both the singular and the plural form of the word.

Changes have been made to this hierarchical taxonomy since Linnaeus developed the system more than 200 years ago, and we'll talk about those in just a minute. The bottom line, though, is that Linnaeus' system for scientific classification formed the framework that still is being used today. PLAY

BINOMIAL NAME; GENUS AND SPECIES (I/D)

Let's talk for a few minutes about Linnaeus' use of binomial names. Before he embraced this simple naming convention, biologists before him named living things by stringing

together long and incredibly complicated lists of Latin words. In Linnaeus' elegant system, he assigned two Latin names to each organism. The first was its genus name, the second, its species name.

Organisms in the same genus were very similar to one another. Therefore, they all shared the same first word in their Latinized names. The species name usually was an adjective that described the organism in greater detail and distinguished it from others in its genus. PLAY

HOUSE CAT, LYNX, COUGAR (P)

Let's look at cats, for example. Smaller cats are of the genus *Felis*. *Felis catus* is the scientific name for a common house cat. *Felis lynx* is the northern lynx. *Felis concolor* is the eastern cougar.

Note that the genus name always is capitalized, and the species name always is lowercase. And, to be absolutely correct, scientific names should be underlined or italicized.

So *Felis* is the genus name for a large group of animals with similar physical, catlike characteristics. The various species names further describe and differentiate the house cat from its wild relatives. PLAY

LION, LEOPARDS, TIGER (P)

Speaking of wild relatives, another cat genus is *Panthera*. *Panthera leo* is the lion. *Panthera pardus* is the leopard. *Panthera tigris* is the… what? Of course, *Panthera tigris* is the tiger.

Are you beginning to see an elegant pattern here? No matter what the living being, it has a two-word, scientific, Latin name that tells what other living beings it's similar to, and tells something that distinguishes it from others in its genus. PLAY

LINNAEAN HIERARCHICAL TAXONOMY (I/D)

Much of what Linnaeus proposed more than 200 years ago is still valid today. Only now, instead of just kingdom, class, order, family, genus and species, an additional hierarchical category has been added, refining taxonomy even further. PLAY

MODERN HIERARCHICAL TAXONOMY (I/D)

The widely accepted classification system used today, and based on presumed natural relationships between and among living things, has seven categories, not Linnaeus' six. They are, in order from broadest to most specific, kingdom, **phylum** *(IG L1)*, class, order, family, genus and species. Which category is missing from Linnaeus' taxonomy? *[Phylum]* PLAY

MODERN HIERARCHICAL TAXONOMY WITH SUB TAXA (I/D)

One by-the-way note: main taxonomic levels may be divided into smaller groups such as subphylum, subclass, suborder and so forth, helping to classify organisms further. For example, humans are members of the phylum chordata—a group of animals

having notochords at some time in their lives. A notochord is kind of the precursor to a backbone… notochords are made of cartilage and are flexible and serve as central structures that support the bodies of what we'll call "lower" animals. In our initial developmental stage, humans have notochords that later are replaced with backbones. Accordingly, our subphylum is vertebrata, distinguishing us from those animals with permanent notochords. All that is to say that you can expect to encounter sub taxa from time to time when studying classification. PLAY

MODERN HIERARCHICAL TAXONOMY (I/D)

Now, many people have made attempts over time to develop what are known as mnemonic devices to help us remember these seven categories. You know what a mnemonic device is, don't you? *[Accept all reasonable definitions; answer follows.]* A mnemonic device is something intended to aid your memory. Mnemonic comes from the Greek word *mnemonikos* that means "remember." Can you remember that?

Now here's the big question… how is mnemonic spelled? *[Again, accept all reasonable speculation; you might have students write their guesses on the board; answer follows.]* PLAY

MNEMONIC DEVICE; KINGDOM, PHYLUM, CLASS, ORDER, FAMILY, GENUS, SPECIES (I/D)

That silent "M" tends to trip up most people… And sometimes, people want to spell mnemonic with a beginning "p" instead of "m." So then they're confusing it with the word *pneumonic* that has something to do with pneumonia. But you won't do that, right?

Typically, a mnemonic device lumps together familiar words that begin with the same first letters as the unfamiliar words *[Acrostic]*. Or, a mnemonic device can make a memorable word using the first letters of the words to be memorized *[Acronym]*. For example… PLAY

MAP OF GREAT LAKES; HOMES (I/D)

HOMES is a popular mnemonic device for the Great Lakes. Can you tell me why? *[Accept all reasonable speculation; answer follows.]* PLAY

MAP OF GREAT LAKES; LAKES LABELED (I/D)

The H in HOMES stands for Huron, as in Lake Huron; the O for Ontario; the M for Michigan… you get the picture. PLAY

MNEMONIC DEVICE; KINGDOM, PHYLUM, CLASS, ORDER, FAMILY, GENUS, SPECIES (I/D)

Now let's consider these seven categories for classifying living things. What mnemonic device can you invent to help you remember them? *[Give students several minutes to create mnemonic devices. Of course, we could just give them the classic, "King Phillip Came Over From Germany Saturday," or some variation thereof, but then they'd have to remember that phrase, too. So, allow students the time to develop their own that they may be more likely to remember, and, then spend several more minutes letting students share their mnemonic*

devices with their classmates. Be sure students understand that their mnemonic devices can (and should) be phrases, where each word in the phrase begins with the same letter as one of the words they're trying to remember (a la "King Phillip Came Over..."). Students probably would start crying if they had to make a word out of the letters KPCOFGS... At the least, they'd be trying to buy a vowel. Once students have exhausted the mnemonic possibilities, you might have them vote on the most memorable one, or just decide you've had enough, and move on.] PLAY

LINNAEUS' THREE-KINGDOM CLASSIFICATION MODEL (I/D)

Let's look at Linnaeus' early classification once more. As you can see, he identified three kingdoms in which to group stuff found in nature. Two of these kingdoms have withstood the test of time, and still are used in modern taxonomy. Which are they? *[Plants and animals]* Since rocks and minerals are not living, they're now studied, classified and revered in another branch of science called geology. For now, we're concentrating on the classification of living things.

Okay, besides the plant and animal kingdoms, into what other kingdoms are living things grouped? *[Accept all reasoned guesses… this question is meant to reveal any misconceptions students might have as well as give them a chance to show what they know.]* PLAY

MODERN, FIVE-KINGDOM CLASSIFICATION SYSTEM (I/D)

Today, the most widely accepted, and widely taught, classification scheme is this five-kingdom model… but actually, that may be about to change; more on the reasons why in our next science lesson. For now, let's spend a little time considering this chart, and thinking about what sorts of living beings it represents.

Let's start at the most basic level. What characteristics does something have to have to be considered a living thing? *[Accept all reasonable speculation; write key words and phrases on the board; answer follows.]* PLAY

DEFINITION OF A LIVING THING (I/D)

To earn a place on any taxonomy chart, something first has to be considered as *living* as opposed to being *nonliving* like a rock or your desk. Living things need food for energy to grow and change, and to make more of their own kind. Living things have an orderly structure; they're made of molecules that, when organized, comprise cells. Living things are able to respond to and adapt to their environments.

So, if something's living, it's represented somewhere on a taxonomy chart. PLAY

MODERN, FIVE-KINGDOM CLASSIFICATION SYSTEM (I/D)

Okay, back to our classification system. As mentioned earlier, this five-kingdom model is the one most widely accepted, and widely taught, today. In our upcoming science lessons, we'll learn about members belonging to each of the kingdoms, and their characteristics. For now, let's simply get acquainted with their names.

To which kingdom do we belong? *[Kingdom Animalia]* All animals belong to the **Kingdom Animalia** *(IG L1)*. By the way, if the word *Animalia* sounds a little strange or different, it's just because it's a Latin word. All the kingdom names are from the Latin or Greek languages.

The kingdom containing all plants, both living and extinct, is the **Kingdom Plantae** *(IG L1) [PLAN tee]*.

What do you think belongs to the **Kingdom Fungi** *(IG L1)*? *[Accept all reasonable speculation.]* Yeasts, molds and mushrooms all are in the Kingdom Fungi.

The **Kingdom Protoctista** *(IG L1)* contains both single-cell protists and the multicellular organisms derived from them. Perhaps you've never heard of the kingdom named Protoctista, but you may know it by its former name, **Kingdom Protista** *(IG L1)*. The kingdom name was changed rather recently because the word *Protista* means and implied only single-cell organisms. As you'll see, the Kingdom Protoctista is full of all manner of tiny creatures, and not simply the single-cell variety.

And finally, well… kind of finally, is the **Kingdom Monera** *(IG L1)*. The simplest of all organisms—bacteria, for example—belong to this kingdom. Now, in very recent years, as better tools have been invented to study and analyze the ancestry of these organisms, as well as their physical and chemical properties, some startling discoveries about them have been made. What are those discoveries, you ask? Well, let's just say that the Kingdom Monera is now minus some of its more extreme members. Just where those members went will be explored in our next science class. So, stay tuned for the controversy, and the happy ending, of course.

Dessert

You've got decisions to make!

Option 1. Hands-on Activity (25 minutes)

Have students complete the "Classifying Animals (Part 1)" Hands-on Activity (Pages 24-26). Students work in small groups to construct a classification system for animals using anecdotal knowledge and applying what they think they know or have learned (to this point) about the process of classification. Students study animal pictures, develop criteria for their classification schemes and then create illustrated animal classification charts. *(Note: Part 2 of this activity follows the video portion of Lesson 6, "Kingdom Animalia.")*

Option 2. Reading, Writing and Thinking Activities (25 minutes)

Have students complete the "Classification" Reading Activity (Pages 17-21). Then, students can either complete a writing exercise (Page 22) or prepare a written response to one of the higher-order thinking questions (Page 23).

Option 3. Video Quiz (10 minutes)

Have students take the video quiz. It is intended to check students' mastery of concepts related to the basics of classification. The questions are designed so that you can present them in either of two ways.

Standard Mode { Show the question. Show students four possible answers. Have students choose the best answer and write it down. Show the correct answer.

Challenge Mode { Show the question. Have students write down their answers. Show the correct answer.

Option 4. Review ACTIViewer Recording Sheets (15 minutes)

Have student volunteers refer to their completed ACTIViewer recording sheets to make up questions and quiz fellow classmates. When they're finished, have students file their ACTIViewer recording sheets in a notebook or file folder along with the "Classification" reading passage and related work.

Option 5. Online Research Project (1 hour)

Send students to **www.FreshScience.com/class**. Once there, have students follow the directions provided for researching and then reporting on Dr. Robert Whittaker, an American plant ecologist who suggested the five-kingdom system of classification.

Option 6. Unit Assessment (20 minutes)

Have students complete **Part One** of the Unit Assessment (Pages 225-226).

Hands-on Activity Teacher Notes
Classifying Animals (Part 1)

Student Objectives

- Classifying organisms into groups according to criteria students establish
- Constructing a simple classification system and arranging organisms into that system
- Comparing distinguishing characteristics of organisms

Before You Begin

- Gather the following materials for each group of five or six students each: large piece of construction paper, poster board or foam core board; temporary glue sticks with restickable adhesive; scissors; string or yarn (or markers) to make lines between related or hierarchical groups; markers for titling and labeling. Each student is to supply four to six photos of animals that they either bring from home or download and print out at school.

Procedure

- Organize the class into groups of five or six students each. (As an aside, think about how you created your groupings for this activity and share your criteria with students, or make them guess it, if appropriate.) Distribute activity materials to each group and give copies of the "Classifying Animals (Part 1)" activity sheets (Pages 24-26) to each student.
- Remind students that living things can be classified in many ways. Tell them that the more we observe and know about living things, the better we are able to classify them into useful groups.
- Spend a few minutes reviewing the activity with students and answering any questions they might have.
- Next, have students follow the directions on their activity sheets, including writing responses to the activity questions on separate sheets of paper.
- Once they've analyzed their animals and made their classification charts, tell students that they will revisit these charts after they've studied the animal kingdom in greater detail. For now, have students put their activity sheets and charts in a suitable location for ready retrieval.

Answers to Questions on the Student Activity Sheet

1. Why do you think scientists classify living things? *Classifying living things helps promote understanding of them. As we study groupings of organisms, we can learn more about the similarities and differences of the individuals within the groups; this leads to new knowledge and new ideas about the relationships among organisms. Classification also helps to organize the immense body of living things. Organization leads to a greater ability for people to use the knowledge gained about organisms and to make that knowledge available to others.*
2. What were the key characteristics you used in classifying your animals? *Answers will vary but could include such characteristics as body covering, whether the animal lives on land or in water, the number of appendages the animal has, and so forth.*
3. Why are your classification criteria better than any other group's? *The goal here is to have students compare their efforts with those of their classmates'. It is hoped they will be fair in their analyses and will learn more about suitable criteria by considering what fellow students have done.*
4. If you could classify your animals all over again, what criteria might you add or change? *Again, we want students to analyze their work and consider various options to improve upon it. Remind students that in Part 2 of this activity, they will apply what they've learned about animal classification to reclassify the same animals they classified today.*

Reading Activity
Classification

Why do we classify things? And what if we didn't classify things? Could we go through life easily? Think about it… What if a grocery store just put stuff on vacant shelves? The milk might end up next to the salt. The cereal might be next to the lettuce. How would you ever find anything? You would have to go down every aisle to find your items. When similar types of items are grouped, we can find them more easily. **Classification** helps us keep things in order.

Scientists classify living (and nonliving) things to help make order of nature. Classifying organisms makes it easier to study and compare them. **Aristotle** and **Linnaeus** contributed to the development of the modern classification system. This classification system has seven levels. At each level, beings are put into groups based on their **characteristics**.

Classifying life on Earth is a big job. Many **species** seem unlike any other. A taxonomist's job is to figure out how one species may be like another. Organisms are studied inside and out. Even their chemical makeup is checked.

The first effort to classify things began in about 367 B.C. It was then that Aristotle began to study organisms. He made notes of his findings. In 350 B.C., Aristotle wrote "The History of Animals." He compared, and then reported on, more than 500 animals. He even cut open 50 of them to see their insides.

Aristotle made an effort to group animals. He put those animals that lived on land in one group. He put those animals living in water in another group. He was most involved in the contrast of species; he did less to compare them.

Two thousand years later, in the mid 1700s, a Swede named Carl Linnaeus improved classification. He is known as the "father of modern **taxonomy**." Linnaeus considered both **form** and **structure** when classifying living things.

When Linnaeus was 28, he published his first book. It was *Systema Naturae*. The title means "the order of nature." He wrote his ideas on how to classify life forms. He organized the natural world into three main groups. Those groups were called **kingdoms**. Linnaeus wrote about the animal kingdom, the plant kingdom and the kingdom of stones.

Linnaeus organized the natural world into three main groups.

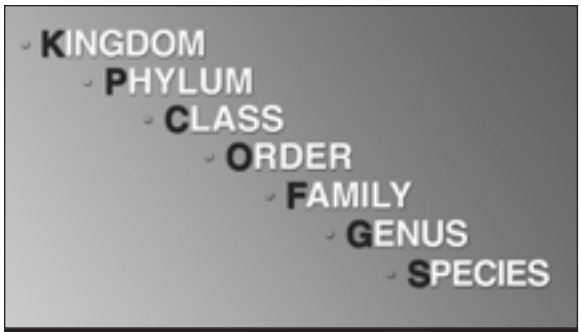
The first edition of *Systema Naturae* had 11 pages. Thirty-five years later, the 13th edition had 3,000 pages. It listed more than 10,000 species! Linnaeus was the first to set up rank-order taxonomy. Each species was assigned a kingdom, a **class**, an **order**, a **family** and a **genus**. Species was the last level in his rank-order system. Organisms of the same species have permanent characteristics in common.

Linnaeus was the first to use a two-word system to name life forms. This system still is used today. In the system, he gave two Latin names to each being. The first name is its genus name, the second, its species name. Beings of the same genus are alike. They have the same first word in their scientific names.

The species name describes the being. The name sets it apart from other species in its genus. For instance, small, catlike animals belong to the genus *Felis*. *Felis catus* is the name for a common house cat. *Felis concolor* is the eastern cougar. *Felis lynx* is the northern lynx. The genus name starts with a capital letter. The species name is lowercase. Scientific names are italicized or underlined.

Much of what Linnaeus proposed 200 years ago still is valid. The main change is the addition of the **phylum** level. That means that today's classification system has seven levels instead of the original six. The seven levels are, in order from broadest to most specific: kingdom, phylum, class, order, family, genus and species.

People invent aids to help remember the seven categories. The aids are mnemonic devices. The word *mnemonic* comes from a Greek word meaning "remember." Most often a mnemonic device strings together known words that begin with the same first letters as the words to be recalled. For example, King Phillip Came Over From Germany Saturday is a phrase to help one remember, in order, the seven taxonomic levels. Each word begins with the same letter as a level — **K**ingdom, **P**hylum, **C**lass, **O**rder, and so forth. Or, a mnemonic device can make a word. It uses the first letters of the words to be recalled. For example, the word *homes* helps one to recall the names of the Great Lakes: **H**uron, **O**ntario, **M**ichigan, **E**rie and **S**uperior.



A mnemonic device can help you recall, in order, the seven taxonomic levels.

Biologists classify living things only. What is the scientific definition of living? Living things need food to grow. They make more of their own kind. Living things have an orderly form. They are made of cells. Rocks are nonliving things.

Living things usually are classified into five kingdoms. Animals belong to the **Kingdom Animalia**. Plants are in the **Kingdom Plantae**. Yeasts, molds and mushrooms are in the **Kingdom Fungi**. The **Kingdom Protoctista**, once called the **Kingdom Protista**, has single-cell protists. It also has multicellular organisms. The simplest of all life forms are in **Kingdom Monera**. Bacteria are in the Kingdom Monera.

Classifying living things helps us to organize nature. Classification helps us to compare and contrast beings. Aristotle and Linnaeus realized long ago the importance of classification. Today, mnemonic devices can help you recall the seven levels of the modern classification system. The next time you go shopping, notice how things are classified in the store. Can you figure out a better system?

Glossary

Aristotle
n. a Greek philosopher (384-322 B.C.) who developed an early system of classification for plants and animals.

characteristic
n. a distinct feature that helps to identify a living thing or object.

class
n. in classification, the level below a phylum (or division) and above an order.

classification
n. the systematic grouping of living things into categories base on structural or evolutionary relationships; taxonomy. *[syn. class]*

family
n. in the classification system of organisms, the level below an order and above a genus.

form
n. the shape of an organism or object.

genus
n. in the classification system of organisms, the level below a family and above a species; usually consists of a group of species having similar characteristics.

kingdom
n. the highest level in a widely accepted classification system based on presumed natural relationships.

Kingdom Animalia
n. the taxonomic kingdom containing all organisms described as being eukaryotic, multicellular, able to move voluntarily, able to reproduce sexually or asexually, and that eat food to obtain nutrients.

Kingdom Fungi
n. the taxonomic kingdom containing all organisms described as being eukaryotic, lacking chlorophyll and vascular tissue, and ranging in form from a single cell to large masses of branched filaments. Fungi absorb nutrients rather than ingest them like animals; they reproduce sexually and asexually. Includes: yeasts, molds, smuts and mushrooms.

Kingdom Monera
n. the taxonomic kingdom containing all organisms described as being prokaryotic and usually unicellular; some, though not all, capable of making their own food. This kingdom used to contain archaeobacteria (archaea) and "true" bacteria. Recently, scientists discovered the distinct differences between archaea and bacteria, and now classify archaea in their own domain and kingdom, separate from other monerans.

Kingdom Plantae
n. the taxonomic kingdom that contains all organisms described as being eukaryotic, typically green and able to make their own food, multicellular and unable to move from place to place.

Kingdom Protista
n. the taxonomic kingdom that contains all organisms described as being neither animals, plants, fungi nor prokaryotes; former name for kingdom that now is called Kingdom Protoctista.

Kingdom Protoctista
n. the taxonomic kingdom that contains all organisms described as being neither animals, plants, fungi nor prokaryotes; formerly called Kingdom Protista, a name that denoted unicellular organisms only, the Kingdom Protoctista contains both unicellular protists and multicellular organisms derived from them. Includes: radiolaria and euglenophyta.

order
n. in the classification system of organisms, the level below a class and above a family.

phylum
n. in the classification system of organisms, the level below a kingdom and above a class.

species
n. in the classification system of organisms, the level below a genus.

structure
n. in anatomy, the arrangement of the parts of an organism.

taxonomy

n. a classification system for organisms that is ordered by similarity of structure, common ancestry or by other relationships; from the Greek *taxis*, meaning "arrangement" and *nomos*, meaning "law." Widely accepted classification levels include, in order from broadest to most specific, kingdom, phylum, class, order, family, genus and species. In recent classification systems, domain is the highest taxonomic level, superseding the kingdom level.

Writing Activity
Classification

Complete your Writing Activity on a separate sheet of paper.

Option 1. Narrative

Aristotle and Linnaeus made major contributions to the classification of living things nearly 1,800 years apart. Surely there must have been others also trying to define and refine classification during that gap in time! Write a story about a fictitious person who lived in 1000 A.D. and who expanded upon Aristotle's early work on classification... but didn't do a very good job.

Tell a story. Show a sequence of events over time. Portray a clear sense of beginning, middle and end. Tell "all about" events clearly and completely.

Option 2. Informative – "How To"

Tell a friend how to make a mnemonic device to remember something important.

Tell all about how to do something. Elaborate the steps so the reader could replicate the activity. Present a logical sequence of steps. Explain the activity and its steps completely and clearly. Remain on topic from beginning to end.

Option 3. Persuasive

During the video lesson, you sorted a number of everyday objects into groups based on your own criteria. Write a one-page paper persuading your classmates that your way of sorting the items was the best way. Be sure to summarize your groupings.

Express your position on a topic. Indicate a position and support that position with reasons. Explain the reasons clearly and completely. Remain on topic from beginning to end

Option 4. Informative – Classification

You now know a little about the classification of living things into the kingdoms Monera, Protoctista, Fungi, Plantae and Animalia. You know that organisms are grouped according to shared characteristics. Rocks, though not living, also are grouped according to shared characteristics. You and your fellow students are grouped into classes. Write about classification in your life. Tell how classification impacts you throughout your day.

Group ideas clearly into categories. Present both sides of the topic (good/bad or positive/negative); however, there does not have to be a balanced presentation. Present information completely and clearly. Remain on topic from beginning to end.

Name _____

Thinking Activity
Classification

Choose a question from one of the three options below. Write your response in the space provided.

Option 1. Analysis

How were the conclusions of Aristotle and Linnaeus the same? How were they different?

Option 2. Synthesis

What if classification was not practiced in everyday life? How would that impact you?

Option 3. Evaluation

In your opinion, what is the most important thing you learned in this lesson? Why?

Hands-on Activity
Classifying Animals (Part 1)

Background

As you have learned, the process of classification is ever evolving. For more than 2,000 years, people have made attempts to quantify and classify the living world. In Part 1 of this activity, you will develop criteria for sorting a group of animals; then, you'll work within your group to create a classification chart that reflects your collective thinking. In Part 2 of this activity, you will compare your animal classification system with the current system that is widely accepted in the scientific community. Then, you will reclassify your animals, applying what you have learned about animal classification.

Materials

25 to 30 animal photos (five or six supplied by each group member)
"Animal Organizer" activity sheet
large piece of construction paper, poster board or foam core board
temporary glue sticks with restickable adhesive
scissors
string or yarn (or markers) to make lines between related or hierarchical groups featured on your poster
markers for titling and labeling

Procedure

1. On a desk or table, or on the floor, spread out your animal pictures for all members in your group to observe and analyze.
2. Record your individual observations of all animals on the "Animal Organizer" activity sheet. As the directions suggest, write several characteristics that describe each animal.
3. Then, as a group, discuss the various characteristics each of you observed and decide which characteristics are best to use when classifying the animals.
4. Next, dab some temporary glue on the back of each picture. Tack the animal pictures to your presentation board in groups according to the characteristics you've chosen. Show hierarchical and other relationships between and among animals by either drawing lines from one group to the next or by stretching a piece of yarn or string between groups (and tacking it down). For example, you might designate "Lives in Water" as one characteristic. Below that, you might have animals that breathe using lungs in one group, and animals that breathe using gills in another. Ideally, you would want to draw a line between each group and the "Lives in Water" characteristic.

5. Store your classification chart in a safe place as you will need it again after you complete the Kingdom Animalia lesson.

Questions

On a separate sheet of paper, write your responses to the following questions.

1. Why do you think scientists classify living things?
2. What were the key characteristics you used in classifying your animals?
3. Why are your classification criteria better than any other group's?
4. If you could classify your animals all over again, what criteria might you add or change?

Name ______________________________

Animal Organizer

On the lines below, write a list of your group's animals. Then, write basic characteristics of each animal beside its name. Such characteristics might include body covering, method of obtaining food, method of reproduction, water or land dwelling, and so forth.

Animal Name	Characteristics

Name _____

ACTIViewer™ Classification

1. Write your definition of **biodiversity**. Then, write the dictionary definition.

2. Write your definition of **classification**. Then, write the dictionary definition.

3. Write or draw a way to arrange, or classify, the following items into groups:

   Tennis ball, eraser, rubber band, paper clip, wood ruler, flashlight, glue stick, bandage, light bulb, glasses, yellow note pad, lollipop, scissors, toy airplane, spoon, battery, pencil, screwdriver, stuffed cat toy, green highlighter marker

4. Who was the earliest person to document his work on scientific observations? How long ago did he do this groundbreaking work, and what was the title of his published work?

5. Who was the Swedish naturalist who helped advance the classification cause? What was his nickname? When did he do his work?

6. Define the terms **taxonomy**, **form** and **structure**.

7. Draw and label the three-kingdom classification model described in *Systema Naturae*.

8. Show the Linnaean model of hierarchical taxonomy.

9. What does **binomial** mean? Give an example of a binomial name.

10. Show the modern model of hierarchical taxonomy.

11. Main taxonomic levels may be divided into such smaller groups as subkingdom, subphylum, subclass, suborder and so forth, helping to classify organisms further. To what subphylum do humans belong?

12. What is a mnemonic device?

13. Create a mnemonic device for the seven main categories used to classify living things.

Kingdom _____

Phylum _____

Class _____

Order _____

Family _____

Genus _____

Species _____

14. What are three characteristics of living things?

_____

_____

_____

15. Draw and label the modern, widely accepted five-kingdom classification model.