SCOPE, SEQUENCE, and COORDINATION

A National Curriculum Project for High School Science Education

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National Science Education Standard—Life Science
Biological Evolution

Biological classifications are based on how organisms are related. Organisms are classified into a hierarchy of groups and subgroups based on similarities which reflect their evolutionary relationships. Species is the most fundamental unit of classification.

The great diversity of organisms is the result of more than 3.5 billion years of evolution that has filled every available niche with life forms.

Teacher Materials

Learning Sequence Item:

901

Classification Schemes

March 1996
Adapted by: William T. George, Lucy Daniels, Linda W. Crow, and Tom Hinojosa

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Biological Classifications: Their Basis in Evolutionary Relationships. Students should understand that a characteristic is a feature that a thing has than can be used in identifying it whereas a trait is a more specific and more narrowly defined characteristic. They should understand how organisms can be categorized based on similar characteristics and that a series of these categories, each of which is called a taxon, makes up a classification system. Students should learn the scheme of hierarchy at the kingdom level—plants, animals, bacteria, fungi, and protists. They can also examine the behavioral patterns of various organisms *(Biology, A Framework for High School Science Education, p. 111).*

Contents

This microunit was adapted by **William T. George** (Georgetown Day School, Washington, D.C.), **Lucy Daniels** (E. Carolina Univ., Greenville, N.C.), **Linda W. Crow** (Baylor College of Medicine, Houston, Tex.), and **Tom Hinojosa** (California SS&C Project, Santa Clara)

901
Learning Sequence

Biological Classifications: Their Basis in Evolutionary Relationships. Students should understand that a characteristic is a feature that a thing has that can be used in identifying it whereas a trait is a more specific and more narrowly defined characteristic. They should understand how organisms can be categorized based on similar characteristics and that a series of these categories, each of which is called a taxon, makes up a classification system. Students should learn the scheme of hierarchy at the kingdom level—plants, animals, bacteria, fungi, and protists. They can also examine the behavioral patterns of various organisms *(Biology, A Framework for High School Science Education, p. 111).*

Science as Inquiry	Science and Technology	Science in Personal and Social Perspectives	History and Nature of Science
Algae Identification **Activity 1** Leaf Impressions **Activity 2** The Face of a Fish **Activity 3** A Sack of Seeds **Activity 4** A Rose by Any Other Name **Activity 5** Classification of Living Things **Activity 6** Identify This **Assessment 1** All in the Family **Assessment 2** Plant or Animal? **Assessment 3** Categorizing Elements **Assessment 4** Rain Forest Explorers **Assessment 5** Class Classification **Assessment 6** Kingdom Relationships **Assessment 7**			

Suggested Sequence of Events

Event #1

Lab Activity

1. Algae Identification (40 minutes)

Alternative or Additional Activities

2. Leaf Impressions (30 minutes)
3. The Face of a Fish (30 minutes)
4. A Sack of Seeds (30 minutes)
5. A Rose by Any Other Name (30 minutes)

Event #2

Lab Activity

6. Classification of Living Things (30 minutes)

Event #3

Readings from Science as Inquiry, Science and Technology, Science in Personal and Social Perspectives, and History and Nature of Science

Suggested readings:

Adler, Z., "New Phylum Found Residing on Lobsters." *Science News*, Vol. 148, No. 125, December 16, 1995.

Bower, B., "Kenyan Fossils Unveil New Hominid Species." *Science News*, Vol. 148, No. 8, August 19, 1995.

Morell, V., "Life on a Grain of Sand." *Discover* Magazine, April 1995, pp. 78–86.

Assessment items are at the back of this volume.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.

2. Open-ended questions asking for essay responses.

3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Science as Inquiry

Algae Identification

How can algae be quickly identified?

Overview:

This activity uses a culture of mixed algae and a identification key to 10 common algae to provide students with practice using a key. The advantage of this exercise is that the students have experiences with live organisms and not just pictures.

Materials:

Per lab group:

culture of common mixed algae (or pond water), 250 mL
suggested types: Diatoms, Oscillatoria, Nostoc, Anabaena, Volvox, Spirogyra, Oedogonium, Hydrodictyon, Chlamydomonas, Euglena
microscope
slides, cover slips, or demo slides, 3
key to common algae (included with Student Materials)

Procedure:

Review with students how a dichotomous key works using the key provided.

Students are given a mixed culture of common algae and a microscope. Using wet mounts or demo slides, students draw and identify with the key the algal types included in the culture. They should make comparisons of the different types of algae they observe. Help them to consider multiple aspects in their comparisons, including morphological characteristics, movement or activity, color, and size. The use of analogies could be helpful. Students are likely to comment that color, shape, and absence or presence of flagella are most useful in the identification process. They should also note that the key helps to narrow down the possible identities of each organism by the process of elimination based upon observable basic characteristics.

Background:

A dichotomous key gives the user two opposite statements about some trait or organism. By choosing the statement that best describes the unknown organism, the user is led to further pairs of statements. By going from one set of statements to another, the name of the organism or its classification group is determined.

Although students will not be using true scientific names in this activity, an understanding of biosystematics will help you introduce them to this field of biology. Systematics is the study of biological diversity and its evolution. Taxonomy, a subdivision of systematics, is the science of biological classification. Taxonomic systems are hierarchical, that is, each higher group contains all the groups below it. A major goal of biological classification systems is to reflect evolutionary relationships among organisms. One of the first taxonomic systems was proposed by Aristotle around 350 BC. He divided living things into two groups, animals and plants. He subdivided animals on the basis of habitat and behavior and plants on the basis of size and structure. This system was used for more than 2,000 years. Many other classification systems have existed, including an early Hindu system in which animals were divided into (1) those with placentas, (2) those formed from eggs, (3) those that generated spontaneously, and (4) those born of vegetable matter.

Modern taxonomy is always associated with Carl Linnaeus (1707–1778), a Swedish biologist. The Linnaeus binomial system assigns each species a two-word Latin name. The first word is its genus, which is followed by the species name. A **genus** is a group of closely related species (the plural of genus is genera). **Species** is the basic lower unit of classification, consisting of a population or series of populations of closely related and similar organisms. Often the name of the person who first proposed the species name is added at the end (e.g., *Homo sapiens* Linnaeus is the name of the modern human species). In the Linnaean system, the species are grouped into **phyla** (singular, phylum). Phyla are grouped into **kingdoms**. Members of the same species that differ in some important way—such as flower size or ear shape—are said to be different **varieties** (see illustration below). Linnaeus developed this system using the reproductive organs of plants and later classified over 18,000 plants.

Before the development of this system, an organism was given a scientific name that was just a short Latin sentence describing its distinguishing features. Linnaeus in *System Naturae* (1735) divided all things into three separate realms: animal, vegetable, and mineral. (Note: a five-kingdom system is commonly used today: Animalia, Plantae, Fungi, Protista, and Monera.)

Modern taxonomists study chromosome structure, DNA base sequence, reproduction, biochemical similarities, and embryology to determine relationships among organisms.

Demo slides allow you to examine organisms using a microscope without making a wet mount. One source is Connecticut Valley Biological (800-628-7748).

Classification under the Linnaean system:

Less Specific **More Specific**

< ——————————————————————— >

KINGDOM	PHYLUM	CLASS	ORDER	FAMILY	GENUS	SPECIES
Animalia	Chordata	Aves (birds)	Passeriformes	Parulidae (song birds)	Dendroica (wood warblers)	Dendroica fusca Blackburnian warbler

Variations:

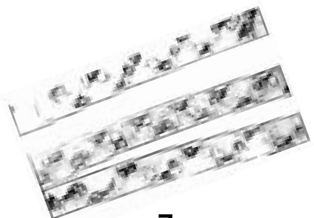
A variety of keys exist for all groups of organisms. Have students collect them and use them.

Adapted from:
Algae, Connecticut Valley Biological Supply Co., Mass., 1996.
Campbell, N.A., *Biology.* Calif.: Benjamin/Cummings Publishing Co., 1990.
Dampier, W.C., *A History of Science.* Cambridge, N.Y., 1943.
Goodman, H.D., L.E. Graham, T.C. Emmel, and Y. Shechter, *Biology Today.* Orlando, Fla.: Holt, Rinehart and Winston/Harcourt Brace Jovanovich, 1991.
Morholt, E. and P. Brandewein, *A Sourcebook for the Biological Sciences,* San Diego, Calif.: F. Harcourt Brace Jovanovich, 1986.
Pendergrass, W.R., *Carolina Protozoa and Invertebrates Manual.* N.C.: Carolina Biological Supply Company, 1980.
Purves, W.K., G.H. Orians, C.H. Heller, *Life: The Science of Biology*, Salt Lake City, Utah: Sinauer Associates, Inc., W.H. Freeman and Co., 1992.
Serafini, A., *The Epic History of Biology,* N.Y.: Plenum Press, 1993.
Williams, T. (ed.), *Biographical Dictionary of Scientists,* Great Britain: Harper Collins Publishers, 1994.

Key to Common Algae

1a.	Color green or blue-green.	go to 2
1b.	Color not green but brownish, with patterned grooves in cell wall.	Diatoms
2a.	Color blue-green; cell without chloroplast or definite nucleus.	go to 3
2b.	Color grass-green; pigment contained in chloroplasts.	go to 4
3a.	Has cells within filaments.	go to 5
3b.	Filaments have cylindrical cells or with oscillating movements.	Oscillatoria
4a.	Algae swimming with flagella.	go to 6
4b.	Algae (no means of locomotion) with filamentous cell organization.	go to 7
5a.	Many filaments contained in a globular sheath.	Nostoc
5b.	Filaments in random arrangement, free connecting mucus.	Anabaenac
6a.	Cells solitary.	go to 8
6b.	Cells in large colonies (500–50,000 cells).	Volvox
7a.	Spiral chloroplast runs through the entire length of the cell.	Spirogyra
7b.	Chloroplast forms a network extending the entire length of the cell.	Oedogonium
7c.	Rod-shaped cells joined in a net-like shape.	Hydrodictyon
8a.	Globular with cup-shaped chloroplast and 2 flagella.	Chlamydomonas
8b.	More than one chloroplast in a cigar-shaped cell and with one flagellum.	Euglena

Diagrams of Suggested Algae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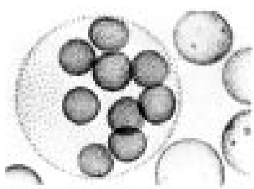
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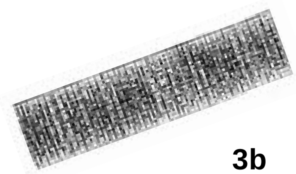
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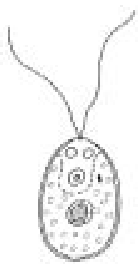
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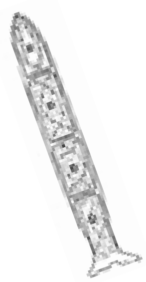
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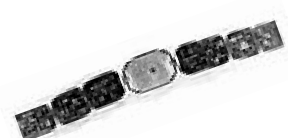
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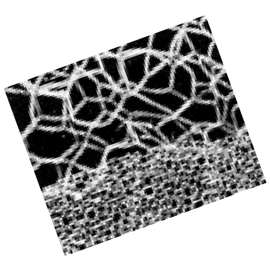
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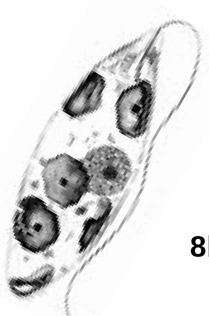
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alternative/extension activity for Event 1

Teacher Sheet

Science as Inquiry

Leaf Impressions

How can leaves be identified?

Overview:

Students use a key to classify leaves. Instead of diagrams of leaves, students can collect leaves and use them in this activity.

Materials:

Per lab group:

dichotomous key to common leaves (example included in Student Materials)
diagram of leaves (example included in Student Materials)

Procedure:

Students may work in pairs or alone. Review with students how a dichotomous key is used. The student should understand that a dichotomous key works in a step-by-step fashion, dividing organisms into two groups, each grouping more specific than the previous one, on the basis of the presence, absence, or degree of development of some characters. Almost any characters can be used as long as they clearly separate the organisms into two distinct groupings. For example, birds could be divided based on whether they have a curved beak or a straight beak; dogs by whether their ears point up or droop down, etc.

Students may have difficulty identifying leaves from the diagram provided. It is recommended that local leaves and an appropriate regional key be used if possible.

Background:

In biology, taxonomy is always associated with Carl Linnaeus. Linnaeus was an 18th-century scientist who developed the binomial system that we use today. This binomial system assigns each species a two-word Latin name. The first word is its genus, which is followed by the species name. Linnaeus developed this system using the reproductive organs of plants and later classified over 18,000 plants.

Before the development of this system, an organism was given a scientific name that was just a short Latin sentence describing its distinguishing features. Linnaeus in *Systema Naturae* (1735) divided all things into three separate realms: animal, vegetable, and mineral. A genus and species name was assigned to all organisms in the animal and vegetable realms. This work became the foundation of modern nomenclature.

See, also, background for Activity 1.

Variations:

Using a dichotomous key to birds, trees, flowers, or reptiles for your geographic area, students can identify as many organisms as they can.

Key to Common Leaves

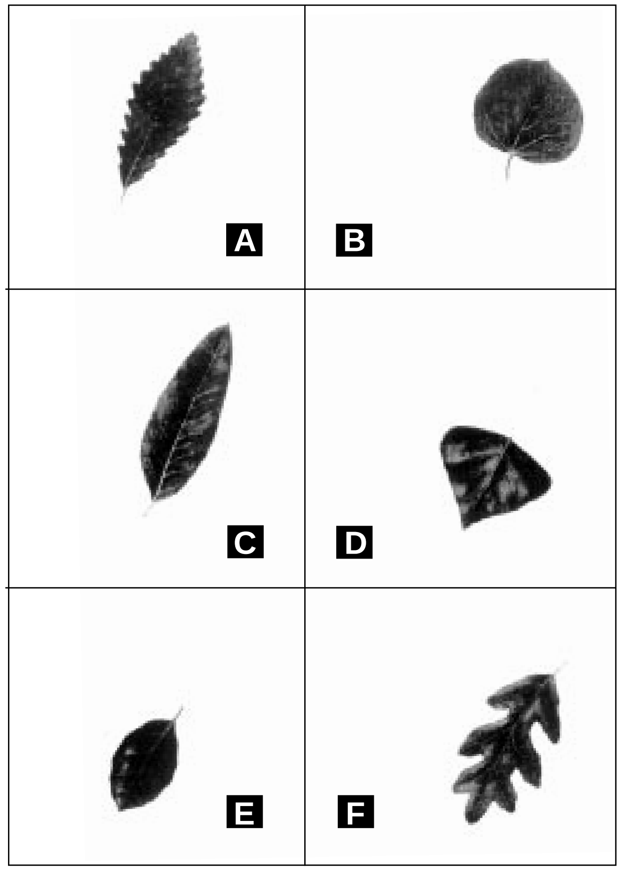
1a. If the edge of the leaf has no teeth, waves, or lobes, go to 2.
1b. If the edge of the leaf has teeth, waves, or lobes, go to 3.

2a. If the leaf has a single bristle at its tip, it is a shingle oak.
2b. If the leaf has no single bristle at its tip, go to 4.

3a. If the leaf edge is toothed, it is a lombardy poplar.
3b. If the leaf edge has waves or lobes, go to 5.

4a. If the leaf is a heart-shaped leaf with veins branching from the base, it is a redbud.
4b. If the leaf is not heart shaped, it is a live oak.

5a. If the leaf edge has lobes, it is an English oak.
5b. If the leaf edge has waves, it is a chestnut oak.



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Williams, T. (ed.). *Biographical Dictionary of Scientists.* Great Britain: Harper Collins Publishers, 1994.

alternative/extension activity for Event 1

Teacher Sheet

Science as Inquiry

The Face of a Fish

How can we identify fish?

Overview:

Students classify fish using a key.

Materials:

Per lab group:

dichotomous key to common fish (included in Student Materials)
diagram of fish (included in Student Materials)

Procedure:

Students may work alone or in pairs. Review with them how a dichotomous key works. Have students examine the dichotomous key to common fish and the associated diagram of typical native fishes. They then choose one fish from the illustration and identify the type of fish using the dichotomous key. They should follow the same procedure for the remaining illustrations of fish. Have them refer to the glossary of terms describing the structure of fish.

Students should note the usefulness of taxonomic keys in identifying an organism and realize that identification could otherwise be very difficult because of the extremely large number of living things on Earth. The use of regional or common names or varying names in other languages could lead to confusion. Furthermore, taxonomic keys help in identifying evolutionary relationships that are important for almost all types of biological investigations.

Students may have difficulty discerning details of the fish diagram provided. It is recommended that appropriate photographs or enhanced diagrams be used.

Background:

In biology, taxonomy is always associated with Carl Linnaeus. Linnaeus was an 18th-century scientist who developed the binomial system that we use today. This binomial system assigns each species a two-word Latin name. The first word is its genus, which is followed by the species name. Linnaeus developed this system using the reproductive organs of plants. He later classified over 18,000 plants.

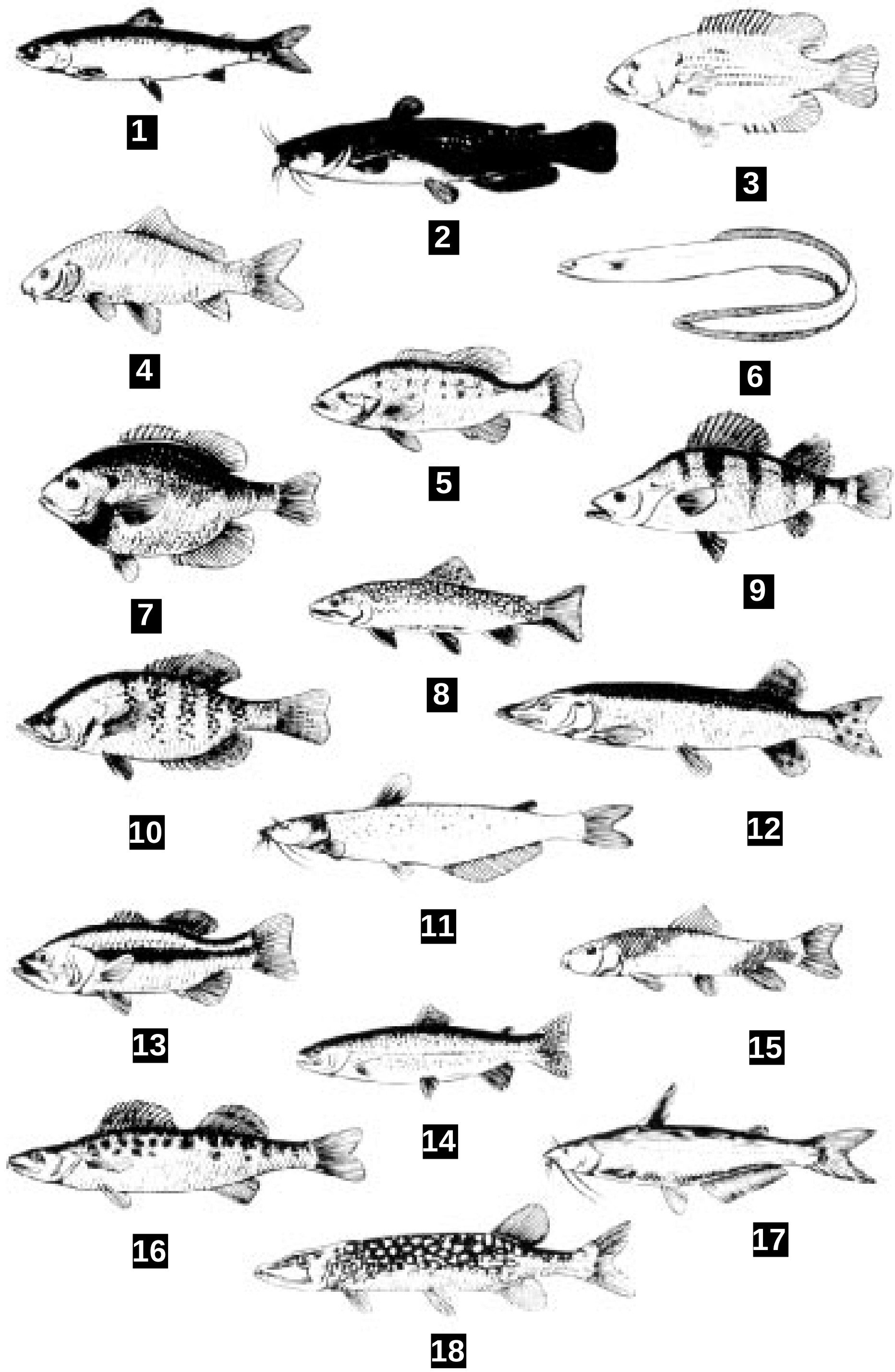
Before the development of this system, an organism was given a scientific name that was just a short Latin sentence describing its distinguishing features. Linnaeus in *Systema Naturae* (1735) divided all things into three separate realms: animal, vegetable, and mineral. A genus and species name was assigned to all organisms in the animal and vegetable realms. This work became the foundation of modern nomenclature.

See, also, background for Activty 1.

Variations:

Using a dichotomous key to birds, trees, flowers, or reptiles for your geographic area, students can identify as many organisms as they can.

Diagrams of Some Typical Native Fishes



Classification Key to Certain Fishes

la. Body noticeably covered with scales—2

lb. Scales not covering body or too small to be seen—12

2a. Dorsal fin single—3

2b. Dorsal fins two or more, joined or separated—6

3a. Body more than four times as long as broad (top to bottom); front edge of dorsal fin far back on body; mouth large, hinge in back of eye 1

3b. Body less than four times as long as broad; front edge of dorsal fin about midway between head and tail; mouth not large, hinge in front of eye—5

4a. Dark lines forming netted design on body; fins not spotted—Pickerel

4b. Body covered with spots; fins spotted—Northern pike

5a. Mouth turned downward; barbels absent; dorsal fin not elongated—White sucker

5b. Mouth not turned downward; barbels present; dorsal fin elongated—Carp

6a. Two dorsal fins separated, the anterior spiny and the posterior soft—7

6b. Two dorsal fins united, forming an anterior spiny portion and a posterior soft portion—8

7a. Top of head concave, fanning a hump in front of dorsal fin; dark vertical bars on body—Yellow perch

7b. Top of head not concave, body sloping to dorsal fin and not forming a hump; dark blotches on body—Walleyed pike

8a. Body more than three times as long as broad—9

8b. Body less than three times as long as broad—10

9a. Hinge of jaws behind the eye; notch between spiny and soft dorsal fin deep and nearly separating into two fins—Largemouth black bass

9b. Hinge of jaws below the eye; notch between spiny and soft dorsal fin not nearly separating into two fins—Small-mouth black bass

10a. Mouth large, hinge below or behind eye—11

10b. Mouth small, hinge in front of eye—Bluegill

11a. Five to seven spines in dorsal fin; dark spots forming broad vertical bars on sides—White crappie

11b. Ten or more spines in dorsal fin; sides flecked with dark spots—Rock bass (Redeye)

12a. Body much elongated and snakelike; dorsal, caudal, and anal fins continuous—Eel

12b. Body not elongated and snakelike; dorsal, caudal, and anal fins separate; adipose fin present—13

13a. Barbels growing from lips and top of head; head large and broad—14

13b. Barbels lacking; head not large and broad—16

14a. Caudal fin deeply forked; head tapering—15

14b. Caudal fin rounded or slightly indented but not forked; head blunt—Bullhead catfish

15a. Dorsal fin rounded at top; body silvery, speckled with black markings—Channel catfish

15b. Dorsal fin long and pointed at top; body bluish-gray without speckles—Blue catfish

16a. Caudal fin deeply forked; back not mottled and with few spots—Atlantic salmon

16b. Caudal fin square or slightly indented; back mottled or spotted—17

17a. Back and caudal fin spotted; broad horizontal band along sides—Rainbow trout

17b. Back mottled with dark lines; caudal fin not spotted; fins edged with white—Brook trout

Glossary

Barbel: A fleshy projection from the lips or head.

Scales: Overlapping outgrowths of the skin.

Fins:
- **Adipose.** A small fin on the top midline of the body near the tail fin.
- **Anal.** A fin along the lower midline of the body near the tail fin.
- **Caudal.** Tail fin.
- **Dorsal.** The fin or fins along the top midline of the body.
- **Pectoral.** Paired fins nearest the head, corresponding to front legs.
- **Pelvic.** The paired fins nearest the tail, corresponding to hind legs.

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Serafini, A., *The Epic History of Biology.* New York: Plenum Press, 1993.
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alternative/extension activity for Event 1

Teacher Sheet

Science as Inquiry

A Sack of Seeds

What properties can be used to classify seeds?

Overview:

Students develop a classification scheme using seeds.

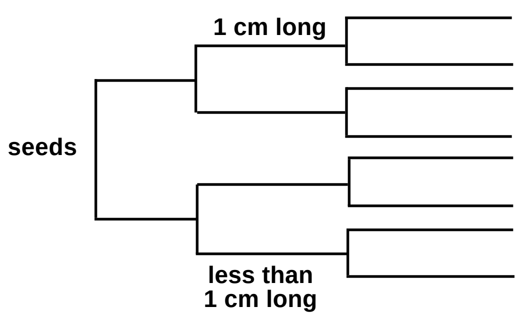
Materials:

Per lab group:

packet of 10 mixed seeds (i.e., lima bean, navy bean, black-eyed peas, dried green peas, great northern beans, black beans, kidney beans, corn seeds, popcorn seeds, sunflower seeds)
hand lens
metric ruler
white paper, 1 sheet

Procedure

Students work in pairs. They first place the seeds on the white paper, observe them with the hand lens, and note the properties of each seed. They then divide the seeds into two groups based on size and further divide each of the two groups based on other features. They should then draw a diagram showing how they divided the seeds. A suggested diagram is shown below.



Students should compare their classification system with others in the class. The systems probably will not be the same, but each will work in identifying the seeds. Students will see that observed properties can be used to classify objects and that almost any characters can be used as long as they clearly separate the organisms into two distinct groupings.

Students should note the usefulness of taxonomic keys in identifying an organism and realize that identification could otherwise be very difficult because of the extremely large number of living things on Earth. The use of regional or common names or varying names in other languages could lead to confusion. Furthermore, taxonomic keys help in identifying evolutionary relationships that are important for almost all types of biological investigations.

Background:

In biology, taxonomy is always associated with Carl Linnaeus. Linnaeus was an 18th-century scientist who developed the binomial system that we use today. This binomial system assigns each species a two-word Latin name. The first word is its genus, which is followed by the species name. Linnaeus developed this system using the reproductive organs of plants and later classified over 18,000 plants.

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Variations:

A variety of keys exist for all groups of organisms. Have students collect them and use them.

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Campbell, N.A., *Biology*. Calif: Benjamin/Cummings Publishing Co., 1990.
Dampier, W.C., *A History of Science*. Cambridge, N.Y., 1943.
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alternative/extension activity for Event 1

Teacher Sheet

Science as Inquiry

A Rose by Any Other Name

How is a key used to identify flowers?

Overview:

Students use a key to classify flowers.

Materials:

Per lab group:

flowers or pictures of flowers (flower seed packets with names removed are a convenient source of flower pictures), 5–6

fruits or vegetables or pictures of fruits and vegetables, 5–6 (alternative)

key to flowers or fruits/vegetables (see below for a key to flowers)

Procedure:

Students may work alone or in pairs. Review with them how a dichotomous key is used. The student will identify flowers and/or fruits and vegetables provided by you using a dichotomous key such as the one below. Have them observe the objects closely as they follow the step-by-step directions. The key below may be used if appropriate flowers or pictures are available (i.e., thistle, daffodil, cornflower, dandelion, poppy).

The student should understand that a dichotomous key works in a step-by-step fashion, dividing organisms into two groups, each grouping more specific than the previous one, on the basis of the presence, absence, or degree of development of some characters. Skipping a step could likely lead to an incorrect identification. Almost any characters can be used as long as they clearly separate the organisms into two distinct groups. Students should note the usefulness of taxonomic keys in identifying an organism and realize that identification could otherwise be very difficult because of the extremely large number of living things on Earth. The use of regional or common names or varying names in other languages could lead to confusion. Furthermore, taxonomic keys help in identifying evolutionary relationships that are important for almost all types of biological investigations.

Key to Flowers

1a. Leaves are broad and toothed: Go to 2.
1b. Leaves are long and slender: Go to 3.

2a. Numerous petals form round, tufted flower: Thistle.
2b. Flower petals are in flat, round layers: Go to 4.

3a. Flower is bell-shaped: Daffodil.
3b. Flower is round and composed of many flowers: Cornflower.

4a. Yellow flower with squared off petals at the outer edge: Dandelion.
4b. Red flower with four petals: Poppy.

Background:

A dichotomous key gives the user two opposite statements about some trait or organism. By choosing the statement that best describes the unknown organism, the user is led to further pairs of statements. By going from one set of statements to another, the name of the organism or its classification group is determined.

Many kinds of classification keys have been developed to identify wildflowers and many other kinds of plants and animals. These keys may vary in purpose and complexity but they share certain features in common. These classification keys are often called dichotomous keys.

Variations:

Students may obtain field guides from the library and examine them to see similarities in members of organisms belonging to the same family.

If the wildflowers in the key are unavailable, pictures may be used. Pictures of fruits and vegetables may also be used.

Students may also use leaves to make a key.

Adapted from: none

Teacher Sheet

Science as Inquiry

Classification of Living Things

How are all living organisms classified?

Overview:

Students are given 25–30 unlabeled (both living and nonliving) objects and are asked to create a classification system for them. In a discussion the students and teacher develop several hierarchical classification schemes and examine the current system used for living organisms.

Materials:

Per lab group:

25–30 living and nonliving objects—different ones can be used for each lab group (include both microscopic and macroscopic organisms, rocks, fossils, preserved specimens that are unusual, nonliving matter submerged in water and sealed in a jar)
representative organism from each kingdom (monera, protist, animal, plant, fungi)
microscope
magnifying glass (hand lens)

Procedure:

Provide students with a set of objects and ask them to devise a classification scheme based upon observable characteristics. They should first list the characteristics of each object (if necessary). After a period of time, have a class discussion and begin as a group to build hierarchical classification systems using these objects. Create several systems and have students examine each one closely, looking for advantages and disadvantages. After this discussion, introduce the terms kingdom, phylum, class, order, family, genus and species. Show how these levels form a hierarchy in the classification system used today. Have students examine representatives from each kingdom and list their characteristics.

Background:

This activity examines both living and nonliving objects to allow students to differentiate between these categories. In addition, the five-kingdom classification system is introduced. This system divides all living organisms into the following kingdoms: Monera, Protista, Fungi, Plantae, and Animalia. These kingdoms are further subdivided into phyla (sing: phylum). Phyla are divided into classes, classes into orders, orders into families, families into genera (sing: genus), and genus into species. As these further subdivisions occur, the groups become smaller and more directly related.

A species represents a unique type of organism and is often described as the evolutionary unit. Species can produce viable offspring when mated.

There are sets of preserved specimens available commercially that may be useful in examining the kingdoms.

Variations:

Provide students with sets of objects, such as buttons or nuts and bolts, for which they develop a classification system.

Allow students to create a new organism that has characteristics of more than one kingdom. Ask them to describe, draw, and name it.

Adapted from:
BSCS Blue Version Test Book, Biological Sciences Curriculum Study, Colorado, 1966.
Kaplan, E.H. *Problem Solving in Biology.* New York: Macmillan Publishing Company, 1976.
Lawson, A.E., *Biology: A Critical Thinking Approach.* Calif: Addison-Wesley Publishing Co., 1994.

Science as Inquiry

Identify This!

Item:

The animal kingdom includes more than one million species of organisms. In order to be classified as an animal, an organism must possess a set of identifiable characteristics. Describe a set of characteristics for an animal and show how one specific example precisely fits your set.

Answer:

The answer depends on the animal chosen, but it should focus on characteristics that differentiate the particular animal from all others while allowing for natural variation that may occur in that species. Students should show an understanding that a characteristic is a feature that a thing has that can be used in identifying it, whereas a trait is a more specific and narrowly defined characteristic.

Science as Inquiry

All in the Family

Item:

Imagine your younger brother or sister is going to the zoo. You want them to locate animals that closely resemble humans (*Homo sapiens*). Prepare a check list of characteristics they should look for. What animals are they likely to find and why?

Answer:

Chimpanzees, gorillas, and orangutans are the most likely candidates. A good checklist should have both physical and behavioral characteristics.

Science as Inquiry

Plant or Animal?

Item:
The plants known as Venus flytrap, sundew, and pitcher plant are very unusual as they are carnivorous and trap insects. They live in acid bog habitats where soil conditions are poor in nitrogen-containing nutrients. These plants have some characteristics in common with both plants and animals. Explain what characteristics might help determine which group (plants or animals) they should be classified with.

Answer:
Answers could include:
- nutrition (photosynthetic as well as chemosynthetic)
- locomotion
- reproduction

Science as Inquiry

Categorizing Elements

Item:

Develop a set of criteria that will allow you to categorize a group of objects (for example, insects or rocks). Base the criteria on important characteristics found in that group.

Answer:

Answers will vary but should focus on characteristics that differentiate that group from all others. For example, if the group is insects, then the criteria should focus on particular insect characteristics like external skeleton, three body sections, usually one pair of antennae, etc.

Science as Inquiry

Rain Forest Explorers

Item:

Deep in the Amazon rain forest a team of explorers came across several plants they could not identify. They decided to radio a plant expert to get help in identifying each plant. If you were there, what important observations could you make and relay to the expert to help in identifying the plants based on the leaves? Prepare a data table for your observations.

Answer:

This item is based on Activity 2. The student should create a data table with suitable categories for various characteristics of leaves. An example is presented below:

Shape of leaf
Type of leaf edges
Leaf vein pattern
Size of leaf

Science as Inquiry

Class Classification

Item:

Create a dichotomous classification system (either/or) for your class. Be sure you end up with only one person in each group. List the characteristics for each division.

Answer:

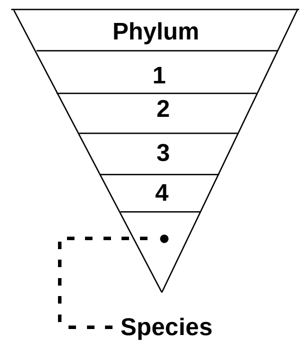
The answer should be judged on its utility in identifying a single individual and the student's apparent understanding of the format and use of a dichotomous key.

Science as Inquiry

Kingdom Relationships

Item:

The classification used for living organisms can easily be represented by an upside-down triangle with the phylum on top and the species at the bottom. Answer the following questions based on the drawing:



1. Which of these divisions contains the greatest variety of organisms (greatest number of different kinds of organisms)?
   A. species
   B. 4
   C. 2
   D. phylum

2. If we studied the animal kingdom and compared phylum to species we would find a(n)
   A. decrease in size of the organisms
   B. increase in variety
   C. increase in relationship between organisms
   D. increase in different kinds of organisms

Answer:

1. D. Phylum is the largest division

2. C. As the divisions become smaller, the closeness of the animals becomes greater.

Consumables

Item	Quantity per lab group	Activity
algae culture, mixed varieties (or pond water)	250 mL	1
cover slips	3	1
diagram of leaves (included with activity)	1	2*
diagram of fish (included with activity)	1	3*
flowers (or pictures of flowers)	5–6	5*
fruits/vegetables (or pictures)	5–6	5*
living and nonliving objects (can be different for each group; include both micro- and macroscopic organisms, rocks, fossils, preserved specimens, nonliving matter submerged in water and sealed in a jar)	25–30	6
microscope slides, cover slips, or demo slides	3	1
paper, plain white, 8.5 × 11	1	4*
key to common algae (included with activity)	1	1
key to common leaves (included with activity)	1	2*
key to common fish (included with activity)	1	3*
key to flowers or fruits/vegetables (example of flower key included with activity)	1	5*
representative organism from each biological kingdom:monera, protista, animal, plant, fungi	1 from each	6*
seeds, mixed packet of ten (e.g., lima bean, navy bean, blackeyed pea, dried green bean, pea, great northern bean, kidney bean,\ corn seed, popcorn seed, sunflower seed)	1	4*

Nonconsumables

Item	Quantity per lab group	Activity
compound microscope	1	6
hand lens	1	4*, 6
metric ruler	1	4*

*alternative or additional activity

Key to activities:
1. Algae Identification
2. Leaf Impressions
3. The Face of a Fish
4. A Sack of Seeds
5. A Rose by Any Other Name
6. Classification of Living Things

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