

Real Science-4-Kids

Teacher's Manual

Level I

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Biology





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A note from the author

This curriculum is designed to give students both solid science information and hands-on experimentation. This level is geared towards fourth to fifth grades and much of the information in the text is very different from what is taught at this grade level in other textbooks. However, I feel that students beginning in the fourth grade can grasp most of the concepts presented here. This is a *real science* text and so scientific terms are used throughout. It is not important at this time for the students to master the terminology, but it is important that they be exposed to the real terms used to describe science.

Each chapter has two parts: a reading part and an experimental part. In the teacher's text, an estimate is given for the time needed to complete each chapter. It is not important that both the reading portion and the experimental portion be concluded in a single sitting. It may be better to split these into two separate days depending on the interest level of the child, and the energy level of the teacher. Also, questions not addressed in the teacher's manual may arise, and extra time may be required to investigate these questions before proceeding with the experimental section.

Each experiment is a *real science* experiment and not just a demonstration. These are designed to engage the students in an actual scientific investigation. The experiments are simple, but are written the way real scientists actually perform experiments in the laboratory. With this foundation, it is my hope that the students will eventually begin to think of their own experiments and test their own ideas scientifically.

Enjoy!
R. W. Keller

How to use this manual

This teacher's manual provides additional information and answers to the laboratory experiments and review pages for Biology. The additional information for each chapter is provided as supplementary material in case questions arise while reading the text. It is not necessary for the students to learn this additional material as most of it is beyond the scope of this level. However, the teacher may find it useful for answering questions.

The laboratory section (or Experiments) together with the Review are found at the end of each chapter. All of the experiments have been tested, but it is not unusual for an experiment to fail. Usually repeating an experiment helps both student and teacher see where an error may have been made. However, not all repeated experiments work either. Do not worry if an experiment fails. Encourage the student to troubleshoot and investigate possible errors.

Getting started

The easiest way to follow this curriculum is to have all of the materials needed for each lesson ready before you begin. A small shelf or cupboard or even a plastic bin can be dedicated to holding most of the necessary chemicals and equipment. Those items that need to be fresh are indicated at the beginning of each lesson. The following is a partial list of chemicals and equipment required for the experiments:

marking pens for writing on glass or wax paper
several small jars (baby food jars)
two large glass jars (pickle or mayonnaise jar)

lightweight cardboard or construction paper
clear tape
food coloring
absorbent white paper (such as coffee filters)
plastic wrap
rubber bands
microscope with 10X objective
eye droppers (3)
distilled water
microscope slides

Several experiments require living organisms. Some of these can be found in the backyard or local environment. Some living things may also be purchased from a local pet store. If necessary, all of the living things can be purchased from internet sources. Carolina Biological Supply Company is a recommended source and all experiments involving living things have been conducted using products from this company. Two other biological supply companies are also listed, but their products have not been tested.

Carolina Biological Supply Co. www.carolina.com

Berkshire Biological www.berkshirebio.com

Blue Spruce Biological Supply www.bluebio.com

Tobin's Lab www.tobinslab.com

Laboratory Safety

Most of these experiments use household items. However, some items are poisonous. Extra care should be taken while working with all chemicals in this series of experiments. Outlined below are some general laboratory precautions that should be applied to the home laboratory:

Never put things in your mouth except if the experiment tells you to. This means that food items should not be eaten unless it is part of the experiment.

Use safety glasses while using glass objects or strong chemicals such as bleach

Wash hands after handling all chemicals.

Use adult supervision while working with iodine, glassware, and any step requiring a stove.

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Chapter 1: Living Creatures

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Time Required:

Text reading - 1 hour

Experimental - 30 minutes

Experimental Pre-setup:

NONE

Additional Materials:

See materials list for Experiment 1

Overall Objectives

This chapter introduces the field of science concerned with the study of living things, called biology. In this chapter students will learn how living creatures are categorized. Because living creatures have unique features, the students will discover that it is often difficult to make exact categories for all living things and often these categories get changed and outdated. New classification schemes are constantly being tried and rejected.

1.1 The science of life

Explain to the students that there are many different disciplines of biology that deal with different aspects of living things. Some include:

Molecular Biology : the study of the molecules, proteins, and DNA that make up living things.

Cell Biology: the study of the whole cells of living things.

Physiology : studies involving whole animal systems.

Genetics: studies concerned with the genetic information encoded in DNA.

Ecology: the study of living things and their interaction with the environment.

Botany: the study of plants.

Zoology: the study of animals.

1.2 Taxonomy

Discuss with the students that there are many different kinds of living things -- some are similar and some are very different. Have the students list some animals that are similar, like wolves and domestic dogs, and some animals that are different like jellyfish and humans.

Point out to the students that living things differ from non-living things because they are “alive” and eventually cease to be alive, or die. Have the students think about what being “alive” means. Have them come up with their own definition of “living.” Point out that non-living things do not reproduce themselves, are not independently mobile, do not consume food or water, and do not die.

Taxonomy is that branch of science concerned with classifying living things. The term comes from the Greek word taxis meaning “arrangement” and nomos meaning “law.” Carolus Linneaus, a Swedish physician, began the systematic organization of living things into what is now called taxonomy. His system had only two kingdoms: Plants and Animals.

1.3 The kingdoms

Before discussing the various divisions, ask the students how they would classify living things. Ask them to make up their own groups. Answers will vary.

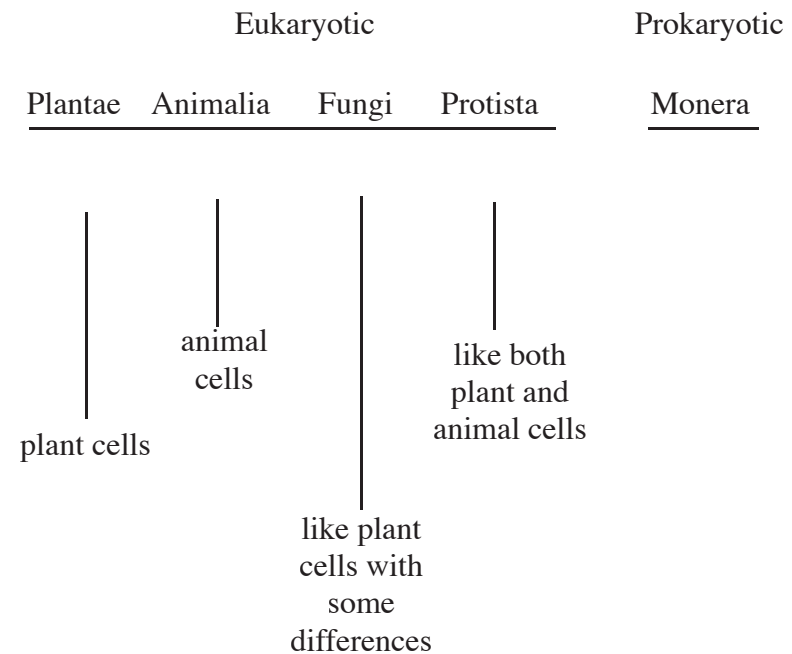
Because of the diversity of living things and because new information about known species continues to be discovered, it has been difficult to establish overall consensus on the classification of all living things. In 1959, Cornell University Professor, R.H. Whittaker, proposed a five-kingdom system that is still used today. This is the system that is presented in this text. However, a four-kingdom system that only recognizes the four kingdoms, Animalia, Plantae, Monera, and Virus has also been proposed along with an eight-kingdom system that recognizes the kingdoms Bacteria, Archaea, Archaezoa, Protista, Chromista, Plantae, Fungi, and Animalia. Also, a three-domain system has been proposed which would include the domains Bacteria, Archaea, and Eukarya.

Originally, the field of taxonomy was created to organize living things as a useful way to separate the various types of life into distinct categories for further study. Today taxonomy is often a branch of evolutionary biology where an evolutionary connection is sought between certain species. For example, the distinction between the two domains Bacteria and Archaea is centered around difference in the ribosomal RNA sequences of species in these domains.

The first task in classifying living things is determining into which kingdom a given organism should be placed. Before the discovery of the microscope, all known living things were classified as either plants or animals. They were placed in these two categories based on their plant- like or animal-like characteristics. However, today an organism is placed into a given kingdom based primarily on the cell type of that organism. Cells are discussed in more detail in Chapter 2.

Although there are five kingdoms, there are not five different cell types. There are two basic cells types, called prokaryotic and eukaryotic

(see Chapter 2). However, there are two different types of eukaryotic cells: plant cells and animal cells. A diagram showing the division of kingdoms based on cell type follows:



In spite of all of the classification difficulties, two main kingdoms stay consistent throughout all of the proposed classification schemes. These are the kingdoms, *Animalia* and *Plantae* (animals and plants).

The animal kingdom includes all animals. The common feature of all animals is the type of cell that all animals have, the animal cell. This is covered in full detail in the next chapter. This is not to say that all animal cells are the same. In fact, animal cells have a wide variety of shapes, sizes, and functions. But all animal cells have some similar features and these features place all animals in the animal kingdom.

Have the students think about what creatures might be in the kingdom *Animalia*. Have them list several creatures. If it is not immediately obvious that an organism is an animal, eliminate it from the other categories first.

For example: A student may say “shrimp,” but maybe it’s not clear that a shrimp is an animal.

Is it a plant? (Plantae) *No*.

Is it a bacteria? (Monera) *No*.

Is it a single-celled organism or does it have both plant and animal like characteristics? (Protista) *No*.

Is it a fungus? (Fungi) *No*

Then it must be an animal, in the kingdom *Animalia*.

The same is true for all plants that are in the plant kingdom. All plants have plant cells and, again, this is covered in full detail in the next chapter. Also, not all plant cells are identical: plant cells vary widely in shape, size, and function, but they all have similar basic features. Repeat the exercise above for plants. This may be trickier since a fungus can also look like a plant. Mushrooms, for example, are fungi, not plants. Use an encyclopedia or other resources if necessary.

The fungi originally were placed in the plant kingdom because they are sedentary like plants. However, fungi differ from plants in that they do not use the sun’s energy for photosynthesis (see Chapter 3) and they differ from plants structurally. They are, therefore, in a kingdom of their own.

The fungi acquire their nutrients by absorption. They have special enzymes on the outside of their bodies that they use to break down their food which they then absorb. There are three basic classifications of fungi: decomposers, the parasites, and symbionts. The decomposers live off non-living organic matter such as fallen logs and animal corpses. The parasites absorb nutrients from a living host but can kill the host, and the symbionts acquire their food from a living host, but they are beneficial to the host they use.

The kingdoms Protista and Monera make up almost all of the microscopic organisms.

The cell type for Protista is actually like a plant and an animal cell, but because they do not fit entirely in either the plant or animal kingdom, they are given their own kingdom. These organisms are explained in more detail in Chapters 6 and 7.

The creatures in the kingdom Monera all have a particular cell type called a prokaryotic cell (see Chapter 2). Their cell shapes are diverse but the most common shapes are rods, spheres, and spirals. *E. coli* is a type of bacteria that is rod-shaped and is found in our stomachs. Pneumonia is caused by a sphere-shaped bacteria.

1.4 Further classification

To further classify all living things, six additional categories are used. These differentiate between the various living things within a given kingdom.

The phylum, class, order, family, genus, and species are the names for these additional categories.

The phylum subdivides the kingdom into different groups. For the kingdom Animalia some of the phylum divisions are:

- Phylum Chordata (those that have a backbone)
- Phylum Mollusca (like clams)
- Phylum Arthropoda (the insects)

The class divides each phylum of a given kingdom into more groups. Some of the classes for the order Chordata are:

- Class Amphibia (the frogs, toads, and newts)
- Class Aves (the birds)
- Class Mammalia (animals with mammary glands for nursing)
- Class Pisces (the bony fishes)

1.5 Naming living things

The order divides the class and the family divides the order. The Family is further divided into the *Genus* and *species*. This final classification gives each different creature a unique “two-name”

designation. The first name is the Genus name which comes from the Latin word for birth or origin and is the generic name for a given organism. It is written with a capital letter and in italics. The second name is the specific name for that particular creature and it is written in lower case and in italics.

The example shown illustrates the different names for four different types of cats. It is not important that the students know all of these names, only that they understand how each is classified.

Point out that the scientific names of all living things are in either Latin or Greek that has been “Latinized” by the addition of Latin endings. Linnaeus, although he spoke Swedish, used Latin to name living things. Latin was the universal language of scientists in his day and he wrote most of his scientific work in Latin to make it available to other scholars. In general, the Latin or Latinized Greek name of a living thing often describes some unique feature of that organism. The name for the bobcat is *Felis rufa*. Rufa is Latin and means red, or ruddy, since the bobcat has a reddish coat.

Not all names given to a specific organism reflect some scientific aspect of that creature. The scientist that discovers the organism has the right to give it its name. Some names reflect where the organism may have been found, and other names may be derived from the Greek myths or in honor of a person.

Experiment: Putting Things in Order Date: _____

Objective: In this experiment we will try to organize a variety of objects into categories.

Materials:

Collect a variety of objects. Some suggestions are: rubber balls, oranges, cotton balls, banana, apple, paper, sticks, leaves, grass, etc.

Experiment:

1. Spread all of the objects on a table. Carefully look at each object and note some their characteristics. For example, some objects will be round, or fuzzy; some will be edible, others not; some may be large, some small, etc.
2. Record your observations for each item in the Results section.
3. Now try to define "categories" for the objects. For example, some objects may be "hard," so one category can be called "Hard." Some objects may be "round," so another category can be "Round." Try to think of at least 4 or 5 different categories for your objects. Write the categories along the top of the graph in the Results section.
4. Now list the objects that fit into these categories. Note those objects that can fit into more than one category. Write these objects down more than once, if necessary, into all of the categories they will fit.
5. Now, take a look at each of the categories and each of the objects in those categories. Can you make "subcategories?" For example, some objects may all have the same color, so, "Red" can be a subcategory or some may be food items so "Food" can be a subcategory. Pick three categories and try to list a couple of subcategories for each of these categories.
6. List the objects according to their category and sub-category.

In this experiment, the students will try to organize several different objects according to some property like shape, color, or texture.

There are no "right" answers for this experiment and the categories the students pick will vary.

Have the students collect a variety of objects.

Have them place the objects on the table and make careful observations. Discuss some features of the objects such as color, shape, and texture. Also, discuss any common uses such as those used as toys or those used as writing instruments.

Have the students write some notes on the objects they have collected. Have them briefly describe each object and list a few of its characteristics.

Next have the students determine some overall categories into which the objects can be divided. For example, marbles, cotton balls, and oranges are round, so "Round" can be a category. Or basketballs, baseballs, and footballs are all balls, so another category can be "Types of Balls." Some items may fit into more than one category. Basketballs can fit into both the category "Round" and "Types of Balls." Write those items that fit into more than one category in all of the categories that they fit.

Next have the students look at each category separately and choose three categories to further divide into subcategories. Decide how to further divide the items into subcategories.

Results:

Item	Characteristics
oranges	round, orange, food, sweet
grapes	oval, food, sweet, green
tennis ball	round, green, fuzzy
marshmallow	white, soft, sweet, shaped like a cylinder
cotton ball	round, white, fuzzy

Have the students record the characteristics of the various items. Help them to be as descriptive as possible.

For example, oranges can be described as round, orange, sweet, food, living, etc. Tennis balls are round, fuzzy, yellow or green (or another color).

Help the students describe, in detail, several different items. Some sample items are listed.

Categories						
white	fuzzy	round	square	hard		
marshmallow	tennis ball	oranges				
cotton ball	cotton ball	tennis ball cotton ball				

White		Fuzzy			
round	food	round	toys		
cotton ball	marshmallow	cotton ball	tennis ball		

Categories

Subcategories

Have the students write the categories at the top of each column. USE PENCIL--they may want to change the categories as more items are being written down.

Decide which items fit into which categories and write those items in the column below the category name.

Pick one to three of the categories and divide them further into subcategories. Try to pick categories so that all of the items are ultimately listed. If necessary, rename some of the general categories to better fit the items listed. Adjust the names of the categories and subcategories as needed so that each item is listed in a category and subcategory. It may be that not all of the items can be placed in a category and a subcategory.

This may be quite challenging. The point of this exercise is to illustrate the difficulty in trying to find a suitable organizational scheme for things with different characteristics.

