Instructional Design

By J. Mele

High School Biology – Evolution unit

The problem is that many students have negative thoughts when it comes to evolution. The topic of evolution is sensitive to most students due to their religious upbringing. The purpose of this unit is NOT to convince students that man came from monkeys or change any students' religious beliefs. The course will provide students with the understanding that different conditions could lead to changes in frequency of alleles in a population. Within the topic of evolution comes the subtopic of origin of life. One goal is to correct any misconceptions student already have about where or how life started. The goal is to educate student on the different historical scientists who have developed experiments to explain how it is possible to create something that could sustain life, while realizing that is very different than creating life. This course is designed to have students accept the concept of biological evolution and relate this information to the world around them. I anticipate based on my previous teaching experience on this unit that students are much more accepting of the topic of evolution, are willing to discuss this topic as it relates to the world around them, especially other scientific areas.

Needs of the learner include making evolution relevant to students (Chiarelott, 2006). Change is taking place around the students all the time. Students agree that technology has "evolved". It has changed to meet the needs of society. We can relate this concept to populations evolving or changing due to the needs of the environment (for survival). Populations change to have a better selection of food, shelter or escape predators, for example.

The rationale behind what in the unit of Evolution in a high school biology class is taught will now be examined in conjunction with why these objectives of the unit are taught in that particular order. I start the unit of evolution with its biological definition of change of frequency of alleles in a population over time because this ties the previous unit of genetics, where alleles are introduced, to this unit. By next giving possible reasons for change as mutations or crossing-over, this too ties the previous unit of genetics to this unit of evolution together. After my pre-assessment of student knowledge with regard to genetics to affirm the students have a clear understanding of genetics, so that they may link it to evolution, I then introduce the concept of what a gene pool is so that students have the ability to calculate the of relative frequency of alleles for a trait. By looking at the actual traits of students in the classroom, the students can relate these terms to themselves and the genetic traits they have. Students then distinguish between monogenic traits where there are only 2 phenotypes for that particular trait (for example, widow's peak hairline present or absent) and polygenic traits (such as height), where there is a multitude of possible phenotypes relating to this trait. Once students have examples that relate to them, they are better equipped to understand how these terms relate to types of natural selection. The reason for introducing the definition of biological evolution at this point is because it would not make sense to the student to introduce the idea of this type of change without first ensuring that the students understand how to calculate the change of frequency of alleles and get an actual number to associate with these changes in nature. The concept of natural selection is then introduced by examining people or animals that live in opposite areas (country vs. city) because these are examples that students can relate to. These students live in the country and have visited a city, even if it is a small city, like

Dayton, Ohio. The examples do not require that students be familiar with a larger city such as Cleveland, Ohio because the differences between the very rural area they live and either city would still be the same. Students will also come up with animals that they have prior knowledge of and list which traits these animals have that allow them to adapt to the habitat in which they live. It is only after students understand what natural selection is from lab activities in both adaptation and natural selection that the 3 types can be given to demonstrate what particular types of changes can take place. Once students realize that natural selection is about being able to survive and reproduce from the examples that they have given regarding the animals they have chosen, it can now be distinguished from genetic drift. Although natural selection may require a population of organisms to move to a different habitat due to lack of either food or shelter for survival, genetic drift is very different. In order for students to understand this, they are given the exercise to come up with different types of natural disasters and discuss what they think happens to the animals that live in the areas where the natural disaster has occurred. Students are asked questions such as "what has happened to the animals?" and "do all the animals go to the same place together?" By thinking about these questions, students realize that animals tend to scatter during natural disasters and not only lose their home, but also their family and the new populations that develop have a gene pool based on chance of which organisms scattered to which location. With these thought-provoking questions that show how populations of organisms can change, I am confident that student will now be able to understand why the 5 conditions to maintain genetic equilibrium (Hardy-Weinberg's Principle) will show how it is possible that populations may not evolve. Examples I give so that students can understand leads to the fact that human populations do not maintain genetic equilibrium because one of the conditions is that there can be no movement into or out of a population and students are familiar with which students have moved into and out of the population that is their small town. Another example regarding humans that is given to the students is that there is no random mating. Students were asked if they would marry anyone, regardless of their personalities or interests shared. Their answer is no. Once students understand that populations may either move due to necessity for survival (natural selection) or by chance (genetic drift), they can now understand the concept of speciation and how new organisms are formed. This leads well into talking about Darwin and his discoveries of natural selection genetic drift, isolation types and speciation of the different organisms he saw, especially on the Galapagos Islands. Since Darwin also found fossils of organisms that were no longer living while on his travels around the world to study nature, it is logical that fossils and geological history of Earth would follow next. Student misconceptions that bones are the only types of fossils are corrected at this time. Once the formation of a fossil is understood, it is then, when how to find out how old the fossils are is explored. Students learn that there are two methods for determining the age of fossils. These two methods are called absolute dating and relative dating. Both the procedures and the results are very different from each other. Absolute dating gives an exact number age of the how the fossil is by calculating the amount of radioactivity that remains in the fossil and comparing it to known radioactive elements. Students calculate this number by determining the fraction of radioactive element left in a fossil to first determine the number of half-lives the sample has gone through. By then calculating the known half-life age of any radioactive element by the number of half-lives the radioactive elements in the fossil has gone through, a true number can be reached.  Relative dating, on the other hand, does not result in a known number, but an estimate age in comparison to other known ages, such as other fossils found in the same rock layer.  It includes the Law of Superposition, which basically states that younger fossil and rock layer are found above those older ones that lay below it.  It is through these aging methods that organisms can be classified.  Organisms are also classified based on their characteristics and ancestors by examining these fossils.  Students will then explore their own methods for classifying a variety of items to understand what concerns need to be addressed in a classification system such as our binomial nomenclature system set up by Linnaeus in the 1700s that is still used to this day.  Students will then get to use and make their own dichotomous keys to identify a variety of organisms.  When we further study the plant kingdom, later in the year, students will have an opportunity to use a dichotomous key to identify a variety of plants found on the school's property.

These previously listed objectives of the evolution unit ensure the needs of society are being met by needs including meeting the State of Ohio Academic Content standards as set forth by the State of Ohio Department of Education (2003).  The following are the State Academic Content Standards related to the unit of Evolution:  10$^{th}$ grade Life Science Standards #12, 13, 14, 17, 20, 21, 22, 23, 24 & 26; 10$^{th}$ grade Scientific Inquiry Standards #2, 4 & 5; 10$^{th}$ grade Scientific Ways of Knowing Standards #2 & 3.  Life Science Academic Content Standards #6 & 7 are excellent connecting standards in linking the previous unit of genetics and heredity to the unit of evolution.

My reason for teaching the order that I do is due to my own theoretical ideas, not due to following the textbook or other references. In fact, I do not go in the order of either of the two biology textbooks that I have used in my limited teaching career when teaching the unit on evolution, however I continue to teach in this sequence due to the simple fact that my students understand what I'm teaching as shown by previous years test scores and understanding from pre-assessment of students stating their opinions on the subject matter, including common misconceptions the students initially have prior to the unit lessons. My pre-assessments are based on verbal questioning and not formal paper assessments. I base this on Zemelman's research (Best Practices 2$^{nd}$ edition 1998) regarding evaluation and test score theories as stated in chapter 10.

Now that I've stated what is taught and the rationale for why it is taught in the order as stated above, each of the sample lesson plans will break down what is being taught into each class day (45 minutes) and how each lesson is taught. Many of my lessons involve student activities, either in groups (as in the beginning of the unit to demonstrate adaptation, natural selection, etc…), pairs (for more adaptation examples, creating index fossils, etc…) or individually (for examples of animals characteristics that help them survive, comparing country and city organisms, radioactivity demonstrations, etc…).

Ms. Mele's Daily Lesson Plans

Subject: Biology  Unit: Evolution  Subunit: Relative Dating of Fossils

<u>Content to be learned:</u>

Relative Dating and use of Index Fossil

<u>Introductory Activities (10 minutes):</u>

Notes on relative dating, index fossils and law of superposition.

Textbook page in chapter 14 section 2.

Handout showing law of superposition.

<u>Developmental Activities (30 minutes):</u>

"Modeling Index Fossils" lab

<u>Concluding Activities (5 minutes):</u>

Discussion regarding location & time period of Index Fossils.

Index fossils are most useful when they are found in a wide geographical area and during a short period of time.

<u>Assessment/Evaluation (15 minutes):</u>

Analysis and conclusion questions of lab activity to be finished for homework.

<u>Materials/Resources:</u>

Notes, Modern Biology textbook, "Modeling Index Fossils" lab from Prentice Hall Laboratory Book, writing utensil, sand, salt, leaves, large plain paper, scissors, timer, metric ruler.

Holt, Rinehart and Winston (2002). *Modern biology*, A Harcourt Classroom Education Company, 299-300.

Pearson Prentice Hall. *Biology laboratory manual B*, Pearson Educational Incorporated, 127-130.

<u>Learning Objectives from Ohio Department of Education Academic Content Standards:</u>

Life Science grades 9-10 Ohio academic content standards #24 & 26.

Scientific Inquiry grades 9-10 Ohio academic content standards #2 &4.

Center for Curriculum and Assessment (2003). Academic *Content Standards K-12 Science*, Ohio Department of Education, 143-147.

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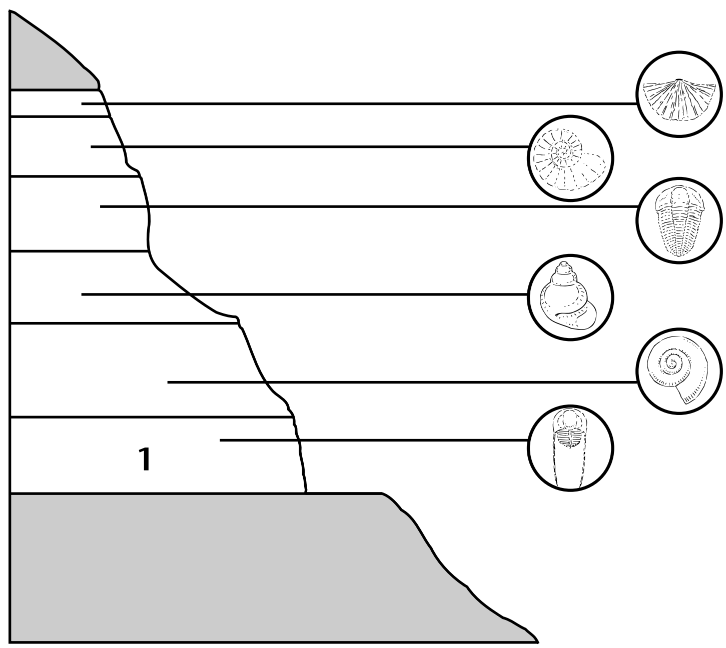
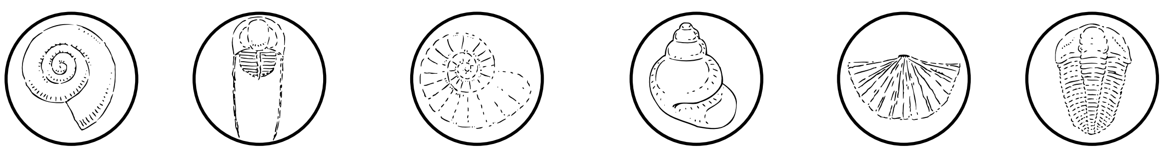
## Relative Age

Sedimentary rock layers form in order by age. The oldest layers are on the bottom, and more recent layers lie above them in the order in which they formed.

*Number the rock layers in the order that they formed. The first one has been done for you.*




*Use the diagram of the rock layers to number the fossils in order. The oldest fossil, labeled 1, has been done for you.*



______   1   ______   ______   ______   ______

*Use the diagram to answer the question.*

**1.** Suppose that you found a fossil of the same species as fossil 1 in a rock layer in another location. What could you conclude about that rock layer?

_______________________________________________________________

_______________________________________________________________

Name______________________________ Class__________________ Date ______________



# Modeling Index Fossils

## Introduction

A fossil is the remains or evidence of an ancient living thing. Fossils of organisms that lived on Earth for only a short time are called index fossils. In this activity you will discover how index fossils can be used to determine the relative ages of rock formations.

## Problem

How can index fossils help determine the relative ages of rock formations?

## Pre-Lab Discussion

Read the entire investigation. Then work with a partner to answer the following questions.

**1.** What do the sand and the salt in the beakers represent?

_______________________________________________

**2.** How will you determine the number of "Years Ago" that leaves appeared?

_______________________________________________

_______________________________________________

**3.** Which line in the Data Table represents the present time?

_______________________________________________

**4.** In the Data Table, how many millions of years are represented by 1 minute?

_______________________________________________

**5.** What is an index fossil?

_______________________________________________

## Materials *(per group)*

scissors
construction paper
3 500-mL beakers or glass jars
glass-marking pencil
small leaves
watch or clock with second hand
sand
table salt

## Safety

Put on safety goggles. Put on a laboratory apron. Be careful to avoid breakage when working with glassware. Use caution with sharp instruments. Wash your hands thoroughly after handling plant materials and after carrying out this investigation. Note all safety alert symbols next to the steps in the Procedure and review the meaning of each symbol by referring to Safety Symbols on page 8.

## Procedure

1. Cut a large circle from a piece of construction paper. The circle represents Earth.
2. Use a glass-marking pencil to label the three beakers A, B, and C.
3. Place the construction-paper circle on a desk or table. Place each beaker in a different location on the circle. Each beaker represents the site of a rock formation on Earth.
4. Place a pile of small leaves near, but not on, the circle. The leaves represent an organism that once lived on Earth.
5. Choose a starting time a few minutes from now, and write that time in column 1 of the Data Table opposite the word "start." Then list the times at 3-minute intervals for the next 30 minutes. Your last time should be written opposite the word "stop."
6. In this activity 30 minutes represent 30 million years in Earth's history. In the column labeled "Years Ago (millions)," list the number of years represented by the times in column 1. Begin by writing "30" in the "start" row, then subtract 3 for each of the next 3-minute periods. You should end up with 0 in the "stop" row.
7. With one partner serving as timer, wait until your watch or clock shows the starting time. Then, add about 2 cm of sand to beaker C. The sand represents a layer in the rock formation.
8. At the next listed time, add a 2-cm layer of table salt to beaker C. The salt represents another layer in the rock formation.
9. At the next listed time, add a layer of sand to both beakers A and C.
10. At the next listed time, add a layer of salt to beakers A and C.
11. At the next listed time, add a layer of sand to beakers A and C.
12. The next time listed in the Data Table should correspond with the event "leaves appear." Move the pile of leaves onto the circle. At the correct time, add a layer of salt to beakers A, B, and C. As you add the salt, also add a leaf to each beaker so that the leaf becomes embedded in the salt. Be sure that you can see each leaf clearly throught the side of its beaker.
13. At the next listed time, move the leaves that you have not used off the circle and back onto the table. (This should correspond with the event "leaves die out" in the Data Table.) After you remove the leaves, add a layer of sand to beakers A and B.
14. At the next listed time, add a layer of salt to beakers A and B.
15. At the next listed time, add a layer of sand to beaker B.
16. At the next listed time, add a layer of salt to beaker B.
17. By now you should have reached the last time listed in the Data Table. Add a layer of sand to beaker B. Your beakers should now look like those shown in Figure 1.

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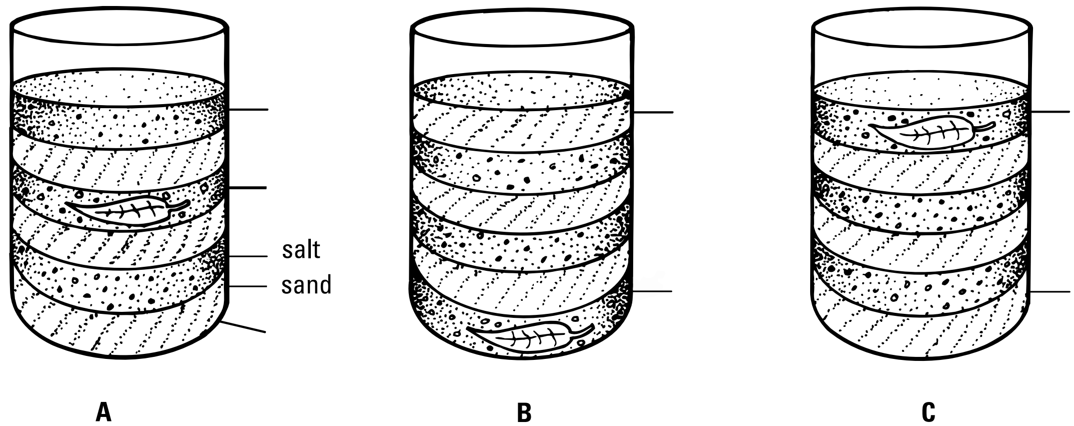


**Figure 1**

**Data Table**

| Time | Event | Years Ago (millions) |
|---|---|---|
| | start | |
| | | |
| | | |
| | | |
| | | |
| | leaves appear | |
| | leaves die out | |
| | | |
| | | |
| | | |
| | stop | |

## Analysis and Conclusions

1. **Inferring** In your model, which "rock layers" are older—those on the top or those on the bottom? Explain why.

_______________________________________________

2. **Calculating** According to your Data Table, how many millions of years ago did leaves appear on Earth? How many millions of years ago did they die out, or become extinct?

_______________________________________________

3. **Analyzing Data** What must be true about the age of rock layers in which leaves appear? Why do you think so?

_______________________________________________

_______________________________________________

4. **Using Models** On the diagram in Figure 1, use an arrow to identify each layer in which a leaf appears. Then label each layer to show the number of years ago that it formed. (For convenience, use the number of years that corresponds to when leaves appeared.)
5. **Classifying** What must be true about the age of the rock layers above the leaf in each beaker? Below the leaf?

   ______________________________________________

   ______________________________________________

6. **Drawing Conclusions** Based on your answer to question 5, which rock formation—A, B, or C—must be the oldest? Explain why.

   ______________________________________________

   ______________________________________________

7. **Inferring** Which rock formation must be the youngest? Why do you think so?

   ______________________________________________

   ______________________________________________

8. **Calculating** Using the leaf as a guide, determine the age of the oldest and youngest rock layer in each beaker. Then label the layers in Figure 1 with this information. Which layers are the oldest and youngest in each beaker?

   ______________________________________________

   ______________________________________________

   ______________________________________________

9. **Drawing Conclusions** How are index fossils used to determine the relative ages of rock formations?

   ______________________________________________

   ______________________________________________

   ______________________________________________

   ______________________________________________

## Going Further

Use the library or the Internet to research dinosaurs, and how scientists have determined when they lived. Did all species of dinosaurs live at the same time? Would dinosaur fossils be of any use as index fossils? Explain your answer.

Ms. Mele's Daily Lesson Plans

Subject: Biology Unit: Evolution

Subunit: Absolute Dating of Fossils

Content to be learned:

Methods to perform radioactive or absolute dating

Introductory Activities (20 minutes):

Notes on radioactive or absolute dating and the definition of half-life.

Textbook page in chapter 14 section 2.

Developmental Activities (10 minutes):

Radioactive decay simulation using pennies.

Concluding Activities (5 minutes):

Discussion of how absolute dating of fossils is different than relative dating.

Assessment/Evaluation (20 minutes):

Practice problems finding the absolute age of fossils in class. Finish practice remaining practice problems for homework.

Materials/Resources:

Notes, Modern Biology textbook, writing utensil, pennies and calculator.

Holt, Rinehart and Winston (2002). *Modern biology*, A Harcourt Classroom Education Company, 299-300.

Learning Objectives from Ohio Department of Education Academic Content Standards:

Life Science grades 9-10 Ohio academic content standards #23.

Scientific Inquiry grades 9-10 Ohio academic content standards #3 and 5.

Center for Curriculum and Assessment (2003). Academic *Content Standards K-12 Science*, Ohio Department of Education, 143-147.

Ms. Mele's Daily Lesson Plans

Subject: Biology | Unit: Evolution

Subunit: Classification – Introduction

## Content to be learned:

What is the most organized way to classify organisms?

## Introductory Activities (10 minutes):

Instructions for grouping 35 different items and naming those groupings. The number of groupings and their names given to their groupings is left to the discretion of the students with the only stipulation is that there can be no group labeled "miscellaneous".

## Developmental Activities (25 minutes):

Actual grouping of these items. Once completed, divide each group into smaller, more specific groups with the same instructions as given in the introductory activities.

## Concluding Activities (10 minutes):

Discussion of how each class group divided their items. A discussion regarding that although each class group divided their items differently, no method was incorrect. A discussion regarding possible problems that can arise for sub-groupings based on how the major groups were divided.

## Assessment/Evaluation (10 minutes):

Review lists that were turned in by the students to make sure there was a logical method to the students' groupings and that the students followed directions correctly.

## Materials/Resources:

Notes, Modern Biology textbook and writing utensil.

Holt, Rinehart and Winston (2002). *Modern biology*, A Harcourt Classroom Education Company, 299-300.

## Learning Objectives from Ohio Department of Education Academic Content Standards:

Life Science grades 9-10 Ohio academic content standards #12.

Scientific Inquiry grades 9-10 Ohio academic content standards #4 and 5.

Center for Curriculum and Assessment (2003). Academic *Content Standards K-12 Science*, Ohio Department of Education, 143-147.

Ms. Mele's Daily Lesson Plans

Subject: Biology | Unit: Evolution

Subunit: Classification – Dichotomous key introduction

## Content to be learned:

Using dichotomous keys to classify organisms.

## Introductory Activities (10 minutes):

Define dichotomous key and explain how it works. Give example of using this method to identify one student in class by their characteristics and clothing they are wearing.

## Developmental Activities (30 minutes):

"Classifying Organisms" lab

## Concluding Activities (10 minutes):

Discussion of methods to make your own dichotomous key to identify wildflowers.

## Assessment/Evaluation (15 minutes):

Analysis and conclusion questions to lab activity - start in class and finish for homework.

## Materials/Resources:

"Classifying Organisms" lab from Prentice Hall Laboratory Book, writing utensil & straight edge.

Pearson Prentice Hall. *Biology laboratory manual A*, Pearson Educational Incorporated, 147-152.

## Learning Objectives from Ohio Department of Education Academic Content Standards:

Life Science grades 9-10 Ohio academic content standards #12.

Scientific Inquiry grades 9-10 Ohio academic content standards #2.

Center for Curriculum and Assessment (2003). Academic *Content Standards K-12 Science*, Ohio Department of Education, 143-147.

Name________________________ Class ______________ Date ____________



# Using and Constructing a Dichotomous Key

## Introduction

All cultures have developed names for the living things found in their environments. When various everyday names are used for the same organism, confusion is possible. So, scientists have developed an international system for naming and classifying all organisms. Identification guides, called keys, have been developed to help all peoples recognize and identify organisms according to their scientific names.

The word *dichotomous* comes from the word *dichotomy,* meaning "two opposite parts or categories." A dichotomous key gives the reader a series of opposing descriptions of basic features of an organism. The reader studies the specimen and selects the descriptions that apply to it until reaching a statement that characterizes only one species and names it. In this investigation, you will use a typical dichotomous key to identify the genus and species of several different salamanders. Then, you will create your own dichotomous key to categorize a diverse group of wildflowers.

## Problem

How is a dichotomous key used to distinguish among similar organisms?

## Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

1. How many choices does a dichotomous key provide at each step?

_______________________________________________

2. What are some of the apparent differences among the salamanders illustrated?

_______________________________________________

_______________________________________________

3. Based on the information in Figure 2, what is a distinguishing characteristic of the members of the genus *Ambystoma*?

_______________________________________________

_______________________________________________

4. What might be a good strategy for beginning to create a dichotomous key for the six types of wildflowers shown in the diagram?

_______________________________________________

_______________________________________________

5. If you were to use live flowers instead of diagrams, what other characteristics could you use to identify the flowers?

_______________________________________________

## Procedure

### Part A: Using a Dichotomous Key

1. Examine the drawings of the salamanders in Figure 1. Choose one salamander to identify by using the key.

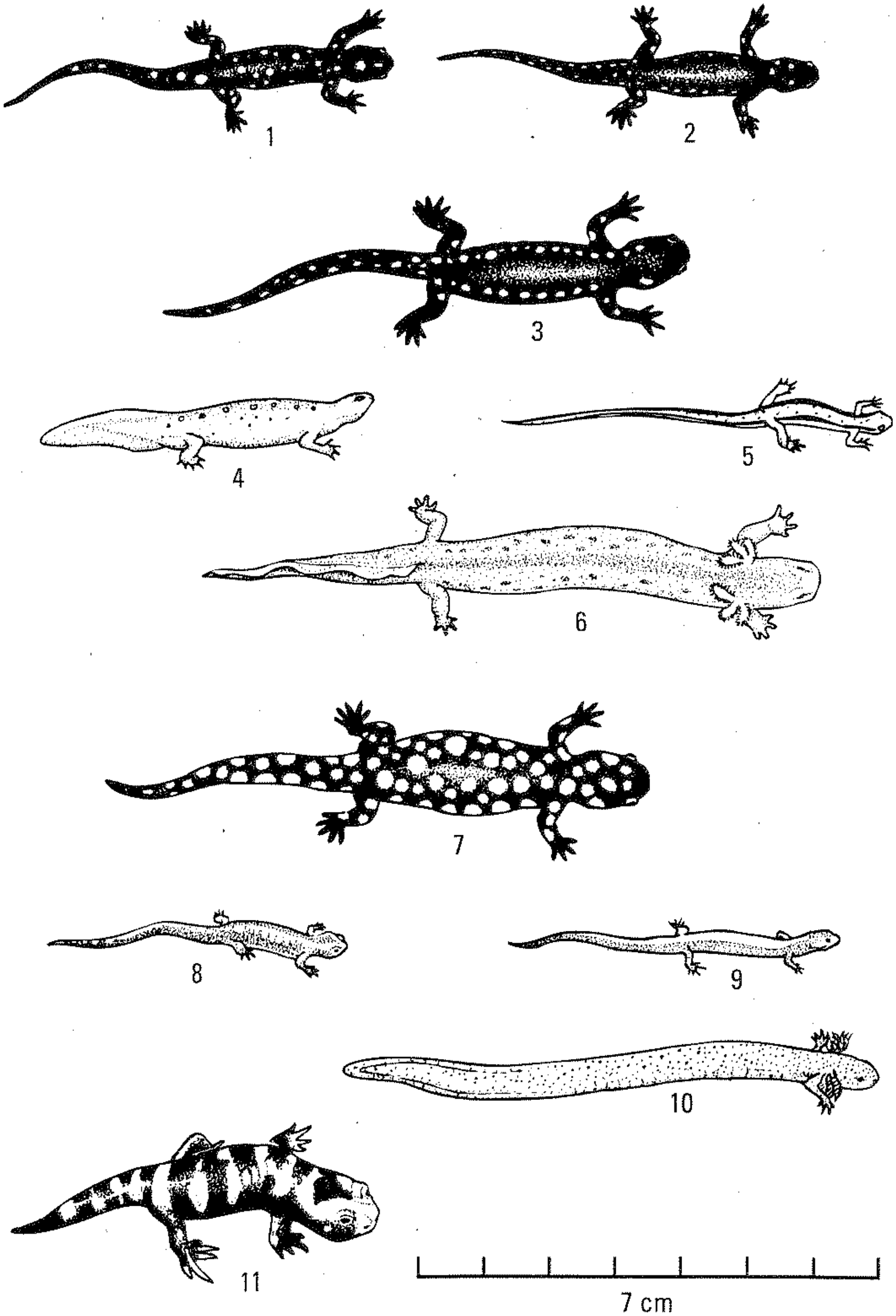


**Figure 1**

Name________________________ Class______________ Date ___________

2. Use the dichotomous key (Figure 2) to determine the genus and species of that salamander. Begin by reading statements 1a and 1b. One of the statements describes the salamander; the other statement does not. Follow the directions for the statement that applies to that salamander and continue following the correct statements until you have identified it. Record the scientific and common name of the salamander in the Data Table on page 150.

3. Repeat step 2 for each of the other salamanders in Figure 1.

| | | | |
|---|---|---|---|
| 1 | a | Hind limbs absent | *Siren intermedia*, siren |
| | b | Hind limbs present | Go to 2 |
| 2 | a | External gills present in adults | *Necturus maculosus*, mud puppy |
| | b | External gills absent in adults | Go to 3 |
| 3 | a | Large size (over 7 cm long in Figure 1) | Go to 4 |
| | b | Small size (under 7 cm long in Figure 1) | Go to 5 |
| 4 | a | Body background black, large white spots variable in size completely covering body and tail | *Ambystoma tigrinum*, tiger salamander |
| | b | Body background black, small round white spots in a row along each side from eye to tip of tail | *Ambystoma maculatum*, spotted salamander |
| 5 | a | Body background black with white spots | Go to 6 |
| | b | Body background light color with dark spots and/or lines on body | Go to 7 |
| 6 | a | Small white spots on black background in a row along each side from head to tip of tail | *Ambystoma jeffersonianum*, Jefferson salamander |
| | b | Small white spots scattered throughout a black background from head to tip of tail | *Plethodon glutinosus*, slimy salamander |
| 7 | a | Large irregular white spots on a black background extending from head to tip of tail | *Ambystoma opacum*, marbled salamander |
| | b | No large irregular black spots on a light background | Go to 8 |
| 8 | a | Round spots scattered along back and sides of body, tail flattened like a tadpole | *Triturus viridescens*, newt |
| | b | Without round spots and tail not flattened like a tadpole | Go to 9 |
| 9 | a | Two dark lines bordering a broad light middorsal stripe with a narrow median dark line extending from the head onto the tail | *Eurycea bislineata*, two-lined salamander |
| | b | Without two dark lines running the length of the body | Go to 10 |
| 10 | a | A light stripe running the length of the body and bordered by dark pigment extending downward on the sides | *Plethodon cinereus*, red-backed salamander |
| | b | A light stripe extending the length of the body without dark pigment on the sides | *Hemidactylium scutatum*, four-toed salamander |

**Figure 2**

**Data Table**

| Number | Genus and species | Common name |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |

## Part B. Constructing a Dichotomous Key

1. Examine Figure 3, which shows some common North American wildflowers. Note different characteristics in flower shape, number of petals, and leaf number and shape.

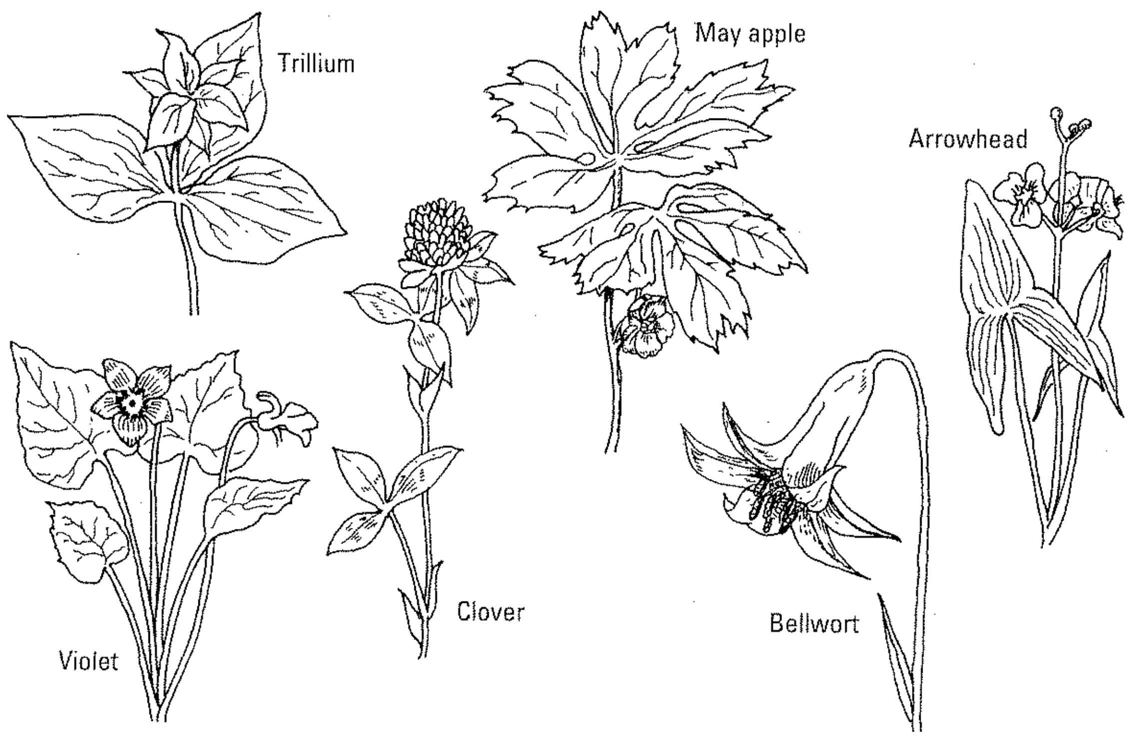


**Figure 3**

Name______________________ Class______________ Date ____________

2. Use the space below to construct a dichotomous key for the wildflowers in Figure 3. Be sure to use enough pairs of statements to have a final positive statement for each to identify each of the six flowers shown. Use the key to salamanders as a model for developing your wildflower key.

3. Check the usefulness of your wildflower key by letting another student see if he or she can use it to identify each pictured flower.

**Wildflower Dichotomous Key**

## Analysis and Conclusions

1. **Analyzing Data** What are some examples of basic differences among the salamanders pictured?

_______________________________________________

_______________________________________________

2. **Drawing Conclusions** Do the dichotomous keys you have just worked with have any limitations in distinguishing between species?

3. **Comparing and Contrasting** Do any of the wildflowers shown in Figure 3 appear to be similar enough to be in the same genus?

4. **Evaluating** What characteristics should be very similar in order to support an inference that two plants are closely related?

5. **Drawing Conclusions** Could the three salamanders from the genus *Ambystoma* be more closely related than *Necturus*, the mud puppy, and *Triturus*, the newt?

## Going Further

Construct an evolutionary tree diagram based on the physical similarities and differences of the salamanders shown in Figure 1. Assume that those most similar share a recent ancestor and those that are most different had a common ancestor long ago. Explain why your evolutionary tree is a hypothesis, and describe what kind of evidence might show whether your hypothesis is correct.

Ms. Mele's Daily Lesson Plans

Subject: Biology Unit: Evolution

Subunit: Classification – Dichotomous key development

Content to be learned:

Using dichotomous keys to classify vertebrates.

Introductory Activities (10 minutes):

Review yesterday's exercise in using a dichotomous key to identify organisms, emphasizing the key uses 2 opposing statements.

Developmental Activities (30 minutes):

"Classification of Vertebrates" lab

Concluding Activities (10 minutes):

Discussion of methods to make your own dichotomous key to identify mythological creatures based on characteristics given.

Assessment/Evaluation (15 minutes):

Analysis and conclusion questions to lab activity start in class and finish for homework.

Materials/Resources:

Pearson Prentice Hall. *Biology laboratory manual B*, Pearson Educational Incorporated, 131-136.

Learning Objectives from Ohio Department of Education Academic Content Standards:

Life Science grades 9-10 Ohio academic content standards #12.

Scientific Inquiry grades 9-10 Ohio academic content standards #2.

Center for Curriculum and Assessment (2003). Academic *Content Standards K-12 Science*, Ohio Department of Education, 143-147.

Name______________________________ Class__________________ Date ______________



# Identifying Vertebrates Using Dichotomous Keys

## Introduction

Organisms such as vertebrates (animals with backbones) are classified into groups according to certain characteristics. Using these characteristics, dichotomous keys can be developed. Biologists develop these dichotomous keys so they can be used to identify unfamiliar organisms. Such keys are also useful in studying common characteristics and relationships among organisms.

In this investigation, you will learn to use a simple dichotomous key to identify some organisms.

## Problem

How is a dichotomous key used to identify various animals?

## Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

**1.** Into which five basic groups will you be classifying vertebrates?

______________________________________________________________

______________________________________________________________

**2.** What information do you need in order to classify the animals shown in Figure 1? Where will you find this information?

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

**3.** What is a dichotomous key?

______________________________________________________________

______________________________________________________________

**4.** What do the **a** and **b** statements in the dichotomous key describe?

______________________________________________________________

______________________________________________________________

**5.** Read statement **1b** in the Dichotomous Key for the Extinct Animals shown in Figure 1. If an animal is ectothermic, what is the next step in the key? Explain.

______________________________________________________________

______________________________________________________________

______________________________________________________________

## Procedure

1. Vertebrates can be divided into five major groups: fishes, amphibians, reptiles, birds, and mammals. (These are not all formal taxonomic groups.) Fishes have gills. The other vertebrates mentioned have lungs. Fishes, amphibians, and reptiles are called ectothermic because they derive body heat mainly from their environment. (*Ecto-* means outside; *-therm* means heat.) Birds and mammals are called endothermic because they derive body heat mainly from metabolism. (*Endo-* means inside.) Some species in each vertebrate group have become extinct. Ten extinct animals are pictured in Figure 1 on pages 132–134. Study the characteristics of these animals by completing the Data Table on page 134.

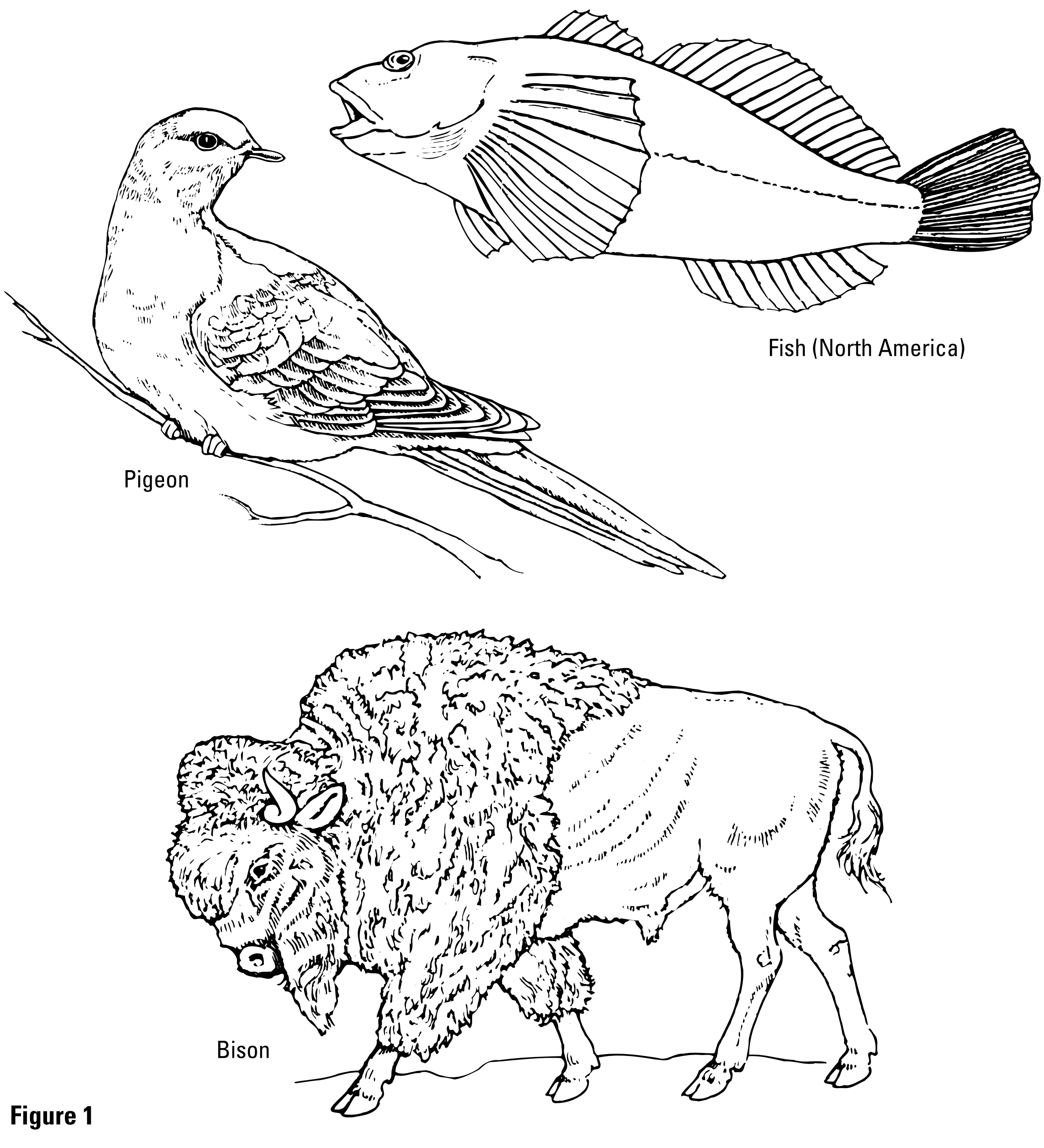


**Figure 1**

Name______________________ Class______________ Date __________

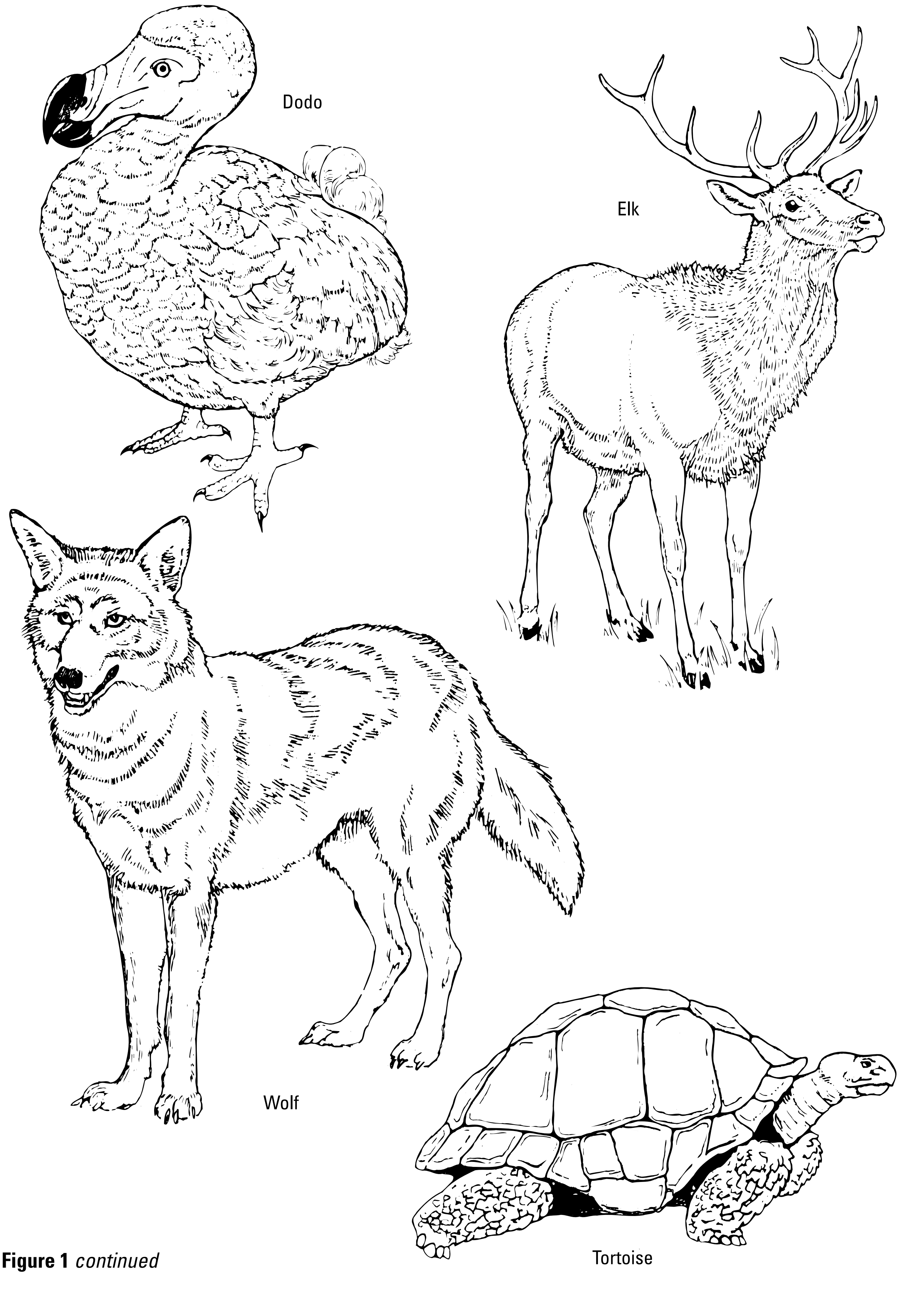


**Figure 1** *continued*

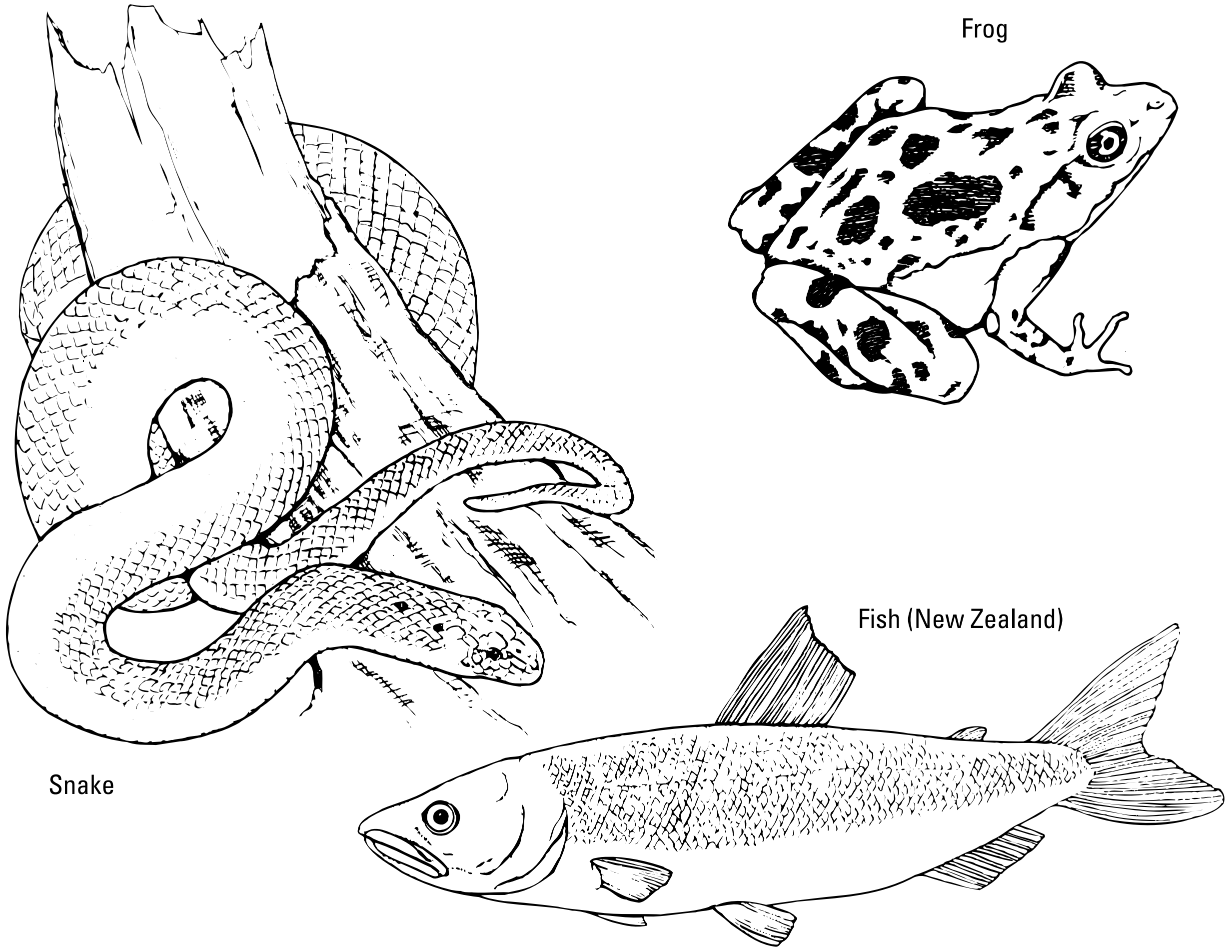


**Figure 1** *continued*

**Data Table**

| Name of Animal | Appendages | | | | | Body Covering | | | | Temperature Regulation | | Breathing Mechanism | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fins | Wings, 2 Legs | Forelegs | Hindlegs | Horns | Smooth skin | Scales | Feathers | Hair/Fur | Ectothermic | Endothermic | Gills | Lungs |
| Tortoise | | | | | | | | | | | | | |
| Dodo | | | | | | | | | | | | | |
| Fish (North America) | | | | | | | | | | | | | |
| Wolf | | | | | | | | | | | | | |
| Pigeon | | | | | | | | | | | | | |
| Elk | | | | | | | | | | | | | |
| Snake | | | | | | | | | | | | | |
| Frog | | | | | | | | | | | | | |
| Bison | | | | | | | | | | | | | |
| Fish (New Zealand) | | | | | | | | | | | | | |

2. The following key is based on information from Figure 1 and the Data Table. Examine how a key works by using it to identify each animal.

**Dichotomous Key for the Extinct Animals Shown in Figure 1**

| | | | |
|---|---|---|---|
| 1 | a | Is endothermic | Go to 2 |
| | b | Is ectothermic | Go to 6 |
| 2 | a | Has feathers | Go to 3 |
| | b | Has hair or fur | Go to 4 |
| 3 | a | Has narrow, straight beak | Passenger pigeon |
| | b | Has wide, crooked beak | Dodo |
| 4 | a | Has horns | Go to 5 |
| | b | Has no horns | Texas red wolf |
| 5 | a | Horns may have many branches | Eastern elk |
| | b | Horns have no branches | Oregon bison |
| 6 | a | Breathes with gills | Go to 7 |
| | b | Breathes with lungs | Go to 8 |
| 7 | a | Has large, fan-shaped fins just behind the head | Utah Lake sculpin |
| | b | Has small pectoral fins | New Zealand grayling |
| 8 | a | Has scaly skin | Go to 9 |
| | b | Has smooth skin | Palestinian painted frog |
| 9 | a | Has front and hind legs | Domed tortoise |
| | b | Has no legs | Round Island boa |

## Analysis and Conclusions

1. **Classifying** Reptiles are ectothermic, have scaly skin, and breathe with lungs. Which of the animals in Figure 1 are reptiles?

______________________________________________

2. **Classifying** The Palestinian painted frog is an amphibian. What is one difference between amphibians and reptiles?

______________________________________________

3. **Classifying** Mammals are endothermic, have hair or fur, breathe with lungs. (They also give birth to live young.) Which of the animals in Figure 1 are mammals?

______________________________________________

4. **Classifying** Birds are endothermic vertebrates with feathers and wings. Which animals in Figure 1 are birds?

______________________________________________

5. **Drawing Conclusions** To which vertebrate group do you belong? Explain.

______________________________________________

______________________________________________

6. **Classifying** Develop a dichotomous key for the following mythical creatures. The key has been started for you.

| | |
|---|---|
| SPHINX: | body of lion, upper part a human |
| PEGASUS: | winged horse |
| CHIMERA: | front part a combination of lion and goat, hind part a serpent, breathes fire |
| CENTAUR: | human from head to waist, remainder of body a horse |
| GRIFFIN: | body of a lion, head and wings of an eagle, back covered with feathers |
| UNICORN: | body of a horse, head of a deer, feet of an elephant, tail of a boar, a single black horn in the middle of its forehead |

**Dichotomous Key for Mythical Animals**

| | | |
|---|---|---|
| 1 | **a** Part of body is human | Go to 2 |
| | **b** None of body is human | Go to 3 |
| 2 | **a** | |
| | **b** | |
| 3 | **a** | |
| | **b** | |
| 4 | **a** | |
| | **b** | |
| 5 | **a** | |
| | **b** | |

## Going Further

Choose an organism that you would like to study. Find out how the organism is classified. Try to find out what characteristics are used to classify the organism. Make a chart of your findings. The chart should have columns headed with the terms “kingdom,” “phylum,” “class,” “order,” “family,” “genus,” and “species.” In each column, write the characteristics of the organism that belong under the heading.

Evaluation methods will be used to ensure that students have accepted the definition of biological evolution and can incorporated it in the ever-changing world around them. Performance-based activities, that represent the different sub-units of evolution, include several hands-on activities with written laboratories. These activities and labs should show how concepts such as survival of the fittest, adaptation and natural selection can be demonstrated in today's world. Learning outcomes are listed below with Bloom's taxonomy category in parenthesis after the stated outcome.

Once the unit of Evolution is complete, students should be able to do the following:

Define gene pool. (Knowledge)

Calculate frequency of alleles. (Knowledge)

Compare & contrast monogenic and polygenic traits. (Evaluation, Comprehension & Analysis)

Distinguish between the 3 types of natural selection. (Comprehension)

Analyze & interpret graphs representing the 3 different types of natural selection. (Analysis & Comprehension)

Apply biological evolution to other aspects in the world. (Application)

Describe genetic drift and how it relates to the Founder's Effect. (Knowledge)

List the 5 conditions for genetic equilibrium and explain why these conditions must exist to maintain genetic equilibrium. (Knowledge, Analysis & Comprehension)

Evaluate the formation of new species by reproductive isolation. (Evaluation)

Explain Darwin's observations how these observations relate to natural selection, speciation and evolution. (Evaluation & Comprehension)

Identify Fossil types and their similarities & differences. (Knowledge)

Determine the age of fossils by radioactive & relative dating methods. (Application)

Examine the geological eras and organisms alive during the periods of these eras. (Knowledge)

Differentiate between the different classifications of organisms & why they are classified in that manner. (Comprehension)

Name: ________________________ Class: ___________________ Date: __________ ID: B

# Mutations, Natural Selection & Population Genetics

**Multiple Choice**
*Identify the letter of the choice that best completes the statement or answers the question.*

____ 1. All the genes of all members of a particular population make up the population's
a. phenotype.
b. relative frequency.
c. gene pool.
d. genotype.

____ 2. Which statement below about gene pools is typically true?
a. They belong to two or more interbreeding species.
b. They contain two or more alleles for each inheritable trait.
c. The relative frequencies of the alleles never change.
d. They contain only dominant alleles.

____ 3. Interbreeding among members of a population results in
a. different types of alleles in the gene pool.
b. no changes in the relative frequencies of alleles in the gene pool.
c. changes in the relative frequencies of alleles in the gene pool.
d. an absence of genetic variation in the population.

____ 4. In a population, the sum of the relative frequencies of all alleles for a particular trait is
a. dependent on the number of alleles.
b. constantly changing.
c. equal to 100 percent.
d. equal to the number of alleles for the trait.

____ 5. An example of a single-gene trait is
a. weight of human infants at birth.
b. beak size in the Galápagos finches.
c. widow's peak in humans.
d. height in humans.

____ 6. The phenotypes for a typical polygenic trait can often be expressed as
a. allele frequencies.
b. a bell-shaped curve.
c. a bar graph.
d. Mendelian ratios.

____ 7. Compared to a polygenic trait, a single-gene trait tends to have
a. the same number of phenotypes.
b. more phenotypes.
c. fewer phenotypes.
d. phenotypes that form a bell-shaped curve.

____ 8. A polygenic trait can have
a. many possible genotypes, producing many possible phenotypes.
b. fewer phenotypes than most single-gene traits.
c. many possible genotypes, but few possible phenotypes.
d. fewer genotypes than most single-gene traits.

____ 9. Natural selection acts directly on
a. alleles.
b. phenotypes.
c. mutations.
d. genes.

____ 10. Which of the following is NOT a way in which natural selection affects the distribution of phenotypes?
a. directional selection
b. disruptive selection
c. stabilizing selection
d. chance events

____ 11. When individuals at only one end of a bell curve of phenotype frequencies have high fitness, the result is
a. disruptive selection.
b. genetic drift.
c. directional selection.
d. stabilizing selection.

____ 12. When individuals with an average form of a trait have the highest fitness, the result is
a. not predictable.
b. stabilizing selection.
c. disruptive selection.
d. directional selection.

____ 13. If a mutation introduces a new skin color in a lizard population, which factor might determine whether the frequency of the new allele will increase?
a. how many phenotypes the population has
b. whether the mutation was caused by nature or by human intervention
c. whether the mutation makes some lizards more fit for their environment than other lizards
d. how many other alleles are present

____ 14. In genetic drift, allele frequencies change because of
a. chance.
b. genetic equilibrium.
c. mutations.
d. natural selection.

____ 15. Which of the following events do biologists consider a random change?
a. genetic drift
b. speciation
c. disruptive selection
d. directional selection

____ 16. The type of genetic drift that follows the colonization of a new habitat by a small group of individuals is called
a. stabilizing selection.
b. the Hardy-Weinberg principle.
c. directional selection.
d. the founder effect.

____ 17. One similarity between natural selection and genetic drift is that both events
a. involve a change in a population's allele frequencies.
b. are based completely on chance.
c. take place only in very small groups.
d. begin with one or more mutations.

____ 18. The situation in which allele frequencies of a population remain constant is called
a. genetic equilibrium.
b. genetic drift.
c. evolution.
d. natural selection.

____ 19. One of the conditions required to maintain genetic equilibrium is
a. natural selection.
b. mutations.
c. no movement into or out of the population.
d. nonrandom mating.

____ 20. The genetic equilibrium of a population can be disturbed by each of the following EXCEPT
a. a large population size.
b. movement into and out of the population.
c. mutations.
d. nonrandom mating.

____ 21. The allele frequencies of a population are more likely to remain unchanged if
a. the mutation rate increases.
b. all mating is random.
c. the population size is reduced.
d. frequent movement into and out of the population occurs.

____ 22. According to the Hardy-Weinberg principle, genetic equilibrium would be more likely in a population of mice if
a. no natural selection takes place.
b. there is frequent movement into and out of the population.
c. the population size rapidly decreases.
d. mutation rates within the population rise.

____ 23. Which factor would most likely disrupt genetic equilibrium in a large population?
a. mating that is not random
b. the absence of movement into and out of the population
c. the absence of mutations
d. the production of large numbers of offspring

____ 24. The separation of populations by barriers such as rivers, mountains, or bodies of water is called
a. genetic equilibrium.
b. temporal isolation.
c. geographic isolation.
d. behavioral isolation.

____ 25. A factor that is necessary for the formation of a new species is
a. different mating behaviors.
b. reproduction at different times.
c. reproductive isolation.
d. geographic barriers.

____ 26. What situation might develop in a population having some plants whose flowers open at midday and other plants whose flowers open late in the day?
a. temporal isolation
b. genetic drift
c. geographic isolation
d. behavioral isolation

____ 27. The geographic isolation of two populations of a species tends to increase differences between their gene pools because it
a. causes temporal isolation of the two populations.
b. prevents interbreeding within each population.
c. increases differences in courtship behavior.
d. prevents interbreeding between the populations.

____ 28. Although they often live in the same habitat, the American toad breeds earlier in the spring than the Fowler's toad does. What can be inferred from this information?
a. The two species do not interbreed because of temporal isolation.
b. The two species interbreed throughout the spring season.
c. The American toad will cause the extinction of the Fowler's toad.
d. The two species do not interbreed because of geographic isolation.

Name: ________________________ Class: ___________________ Date: __________ ID: B

# Population Genetics

## Other

### USING SCIENCE SKILLS

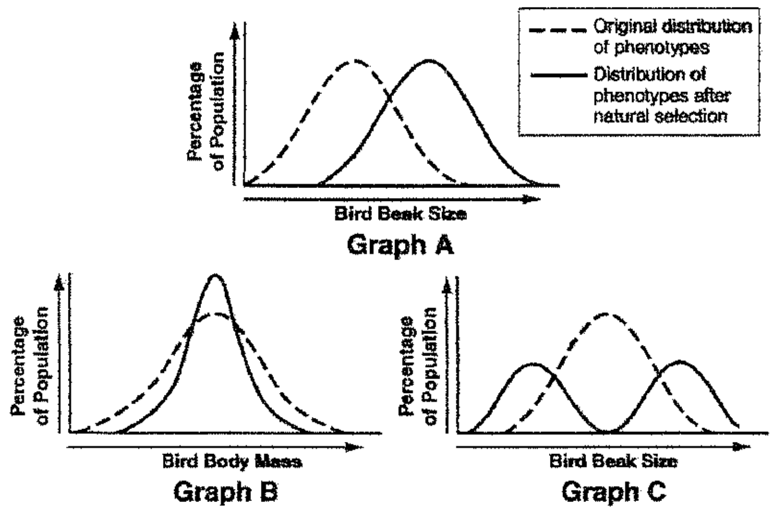


**Figure 16–1**

1. **Interpreting Graphics** According to Graph C in Figure 16–1, what has occurred?

2. **Inferring** What factors or conditions might have led to the change shown in Graph A of Figure 16–1?

3. **Interpreting Graphics** According to Graph B in Figure 16–1, what has occurred?

4. **Interpreting Graphics** According to Graph A in Figure 16–1, what has occurred?

5. **Inferring** Which of the three graphs shown in Figure 16–1 might show a population of birds with members that specialize in different types of food? Explain.

Name: ______________________ ID: B

## USING SCIENCE SKILLS

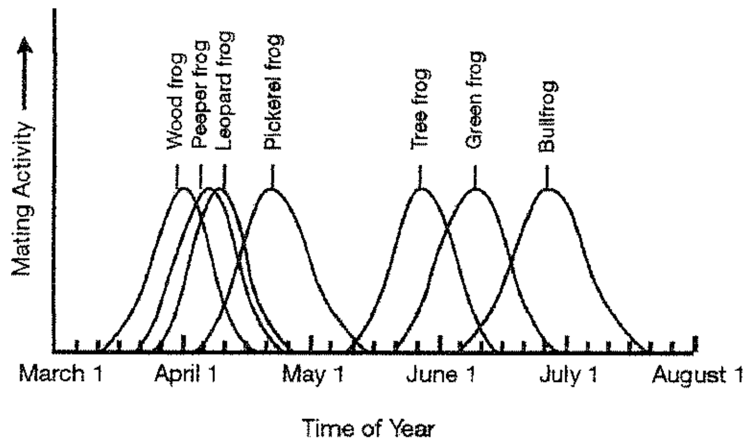


**Figure 16–2**

6. **Interpreting Graphics** Describe the information about frog species that is shown in Figure 16–2.

7. **Inferring** Peeper frogs and leopard frogs do not interbreed even when they share a habitat. Use the information in Figure 16–2 to determine what mechanism probably keeps the two species reproductively isolated.

8. **Interpreting Graphics** According to Figure 16–2, there is a brief period between March and August during which frog mating nearly stops. When does this occur?

9. **Predicting** Frog mating does not occur in cold weather. Assume that the mating times shown in Figure 16–2 are for frogs in the northern part of the United States. How might these curves change for frogs in the southern part of the United States? Explain.

10. **Inferring** Based on Figure 16–2, what mechanism appears to keep bullfrogs reproductively isolated? Would that mechanism necessarily be the only isolating mechanism? Explain.

Name: ________________________ Class: ____________________ Date: __________ ID: B

# Darwin & Fossils

**Multiple Choice**
*Identify the letter of the choice that best completes the statement or answers the question.*

____ 1. One scientist who attempted to explain how rock layers form and change over time was
   a. James Hutton.
   b. Jean-Baptiste Lamarck.
   c. Thomas Malthus.
   d. Charles Darwin.

____ 2. Lamarck proposed that organisms
   a. belong to species that never change.
   b. inherit all of the adaptations they display.
   c. have an innate tendency to become more simple as time passes.
   d. have an innate tendency toward complexity and perfection.

____ 3. Lamarck's theory of evolution includes the concept that new organs in a species appear as a result of
   a. the actions of organisms as they use or fail to use body structures.
   b. an unchanging local environment.
   c. continual increases in population size.
   d. the natural variations already present within the population of organisms.

____ 4. The idea that only famine, disease, and war could prevent the endless growth of human populations was presented by
   a. Malthus.
   b. Darwin.
   c. Lyell.
   d. Lamarck.

____ 5. When Darwin returned from the voyage of the Beagle, he
   a. wrote about his ideas but waited many years to publish them.
   b. immediately published his ideas about evolution.
   c. copied the evolutionary theory of Wallace.
   d. realized his ideas about evolution were wrong.

____ 6. Darwin's concept of evolution was NOT influenced by
   a. knowledge of the structure of DNA.
   b. the work of Lyell.
   c. his trip on the H.M.S. Beagle.
   d. his collection of specimens.

____ 7. Darwin viewed the fossil record as
   a. interesting but unrelated to the evolution of modern species.
   b. evidence that traits are acquired through use or disuse.
   c. evidence that Earth was thousands of years old.
   d. a record of evolution.

____ 8. Darwin's theory of evolution is based on the idea(s) of
   a. the transmission of acquired characteristics.
   b. natural variation and natural selection.
   c. a tendency toward perfect, unchanging species.
   d. use and disuse.

____ 9. James Hutton's and Charles Lyell's work suggested that
a. all rocks on Earth contain fossils.
b. Earth is several thousand years old.
c. Earth is many millions of years old.
d. all fossils were formed in the last one thousand years.

____ 10. In the 1800s, Charles Lyell emphasized that
a. past geological events must be explained in terms of processes observable today.
b. all populations evolve through natural selection.
c. the human population would outgrow the available food supply.
d. Earth is a few thousand years old.

____ 11. What did Darwin learn from reading the work of Hutton and Lyell?
a. All geological change is caused by living organisms.
b. Earth is very old.
c. The processes that formed old rocks on Earth do not operate today.
d. Earth is relatively young.

____ 12. In 1859, Darwin published his revolutionary scientific ideas in a work entitled
a. On the Origin of Species.
b. Essay on the Principle of Population.
c. Principles of Geology.
d. Evolution in Malaysia.

____ 13. Darwin was prompted to publish his theory of evolution by
a. the work of Hutton and Lyell.
b. an essay by Wallace on evolution.
c. the publication of Lamarck's theory of evolution.
d. the captain of the Beagle.

____ 14. In humans, the pelvis and the femur, or thighbone, are involved in walking. In whales, the pelvis and femur shown in Figure 15-2 are

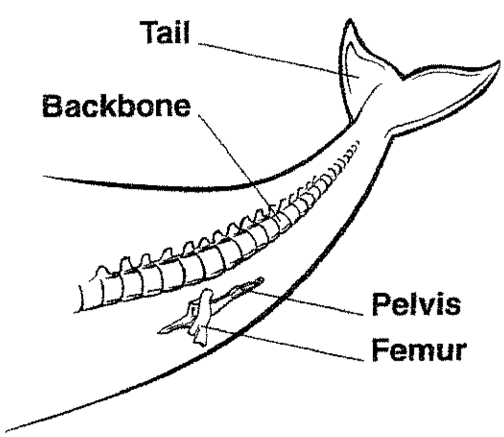


**Figure 15–2**

a. acquired traits.
b. examples of fossils.
c. examples of natural variation.
d. vestigial structures.

____ 15. The economist Thomas Malthus suggested that
a. there would soon be insufficient food for the growing human population.
b. people die faster than babies are born.
c. in the 1700s, England needed more housing.
d. the majority of a species' offspring die.

____ 16. Darwin's theory of evolution suggests that
a. extinct species are not related to living species.
b. species change over time.
c. animals that look alike are the most closely related.
d. different species can interbreed.

____ 17. The hypothesis that species change over time by natural selection was proposed by
a. Hutton.
b. Malthus.
c. Darwin.
d. Lamarck.

____ 18. Sedimentary rock is formed from
a. the hard parts of organisms.
b. the soft parts of organisms.
c. wood, shell, and bone.
d. small particles of sand, silt, and clay.

____ 19. What proportion of all species that ever lived has become extinct?
a. approximately one-half
b. more than 99 percent
c. 100 percent
d. less than 1 percent

____ 20. To be useful as an index fossil, a species must have existed for a
a. long period over a wide geographic range.
b. short period over a wide geographic range.
c. short period over a small geographic range.
d. long period over a small geographic range.

____ 21. The basic divisions of the geologic time scale from larger to smaller are
a. relative and absolute dates.
b. periods and eras.
c. billions of years and millions of years.
d. eras and periods.

____ 22. The Mesozoic Era occurred
a. after the Cenozoic Era.
b. before Precambrian Time.
c. after the Paleozoic Era.
d. during Precambrian Time.

____ 23. Two gases that probably existed in Earth's early atmosphere are
a. water vapor and oxygen.
b. oxygen and carbon monoxide.
c. hydrogen cyanide and carbon monoxide.
d. oxygen and hydrogen sulfide.

____ 24. The process by which two species, for example, a flower and a pollinating insect, evolve in response to each other is called
a. coevolution.
b. adaptive radiation.
c. punctuated equilibrium.
d. convergent evolution.

____ 25. In the past, mass extinctions encouraged the rapid evolution of surviving species
- a. because they killed all organisms that had coevolved.
- b. by changing developmental genes.
- c. because they spared all organisms that had evolved convergently.
- d. by making new habitats available to them.

____ 26. Examples of fossils include preserved
- a. footprints.
- b. eggs.
- c. body parts.
- d. all of the above

____ 27. Most fossils form in
- a. sedimentary rock.
- b. rusty water.
- c. volcanic rocks.
- d. the sap of ancient trees.

____ 28. The length of time required for half of the radioactive atoms in a sample to decay is its
- a. radioactive date.
- b. half-life.
- c. period.
- d. relative date.

____ 29. To compare the relative ages of fossils, scientists sometimes use an easily recognized species called a(an)
- a. carbon fossil.
- b. radioactive fossil.
- c. sedimentary fossil.
- d. index fossil.

____ 30. Earth's most recent era is the
- a. Precambrian.
- b. Mesozoic.
- c. Cenozoic.
- d. Paleozoic.

____ 31. In addition to hydrogen, two of the gases used in Miller and Urey's experiment were
- a. carbon dioxide and hydrogen sulfide.
- b. hydrogen cyanide and oxygen.
- c. methane and ammonia.
- d. nitrogen and carbon monoxide.

____ 32. A very large mass extinction in which trilobites and amphibians disappeared occurred at the end of the
- a. Quaternary Period.
- b. Precambrian Era.
- c. Cambrian Period.
- d. Paleozoic Era.

____ 33. During the Jurassic and Cretaceous periods, the dominant land animals were
- a. grazing mammals.
- b. amphibians.
- c. dinosaurs.
- d. human ancestors.

____ 34. A single species that has evolved into several different forms that live in different ways has undergone
- a. adaptive radiation.
- b. mass extinction.
- c. punctuated equilibrium.
- d. coevolution.

____ 35. Sharks, dolphins, and penguins all have streamlined bodies and appendages that enable them to move through water. These similarities are the result of
- a. asexual reproduction.
- b. convergent evolution.
- c. coevolution.
- d. adaptive radiation.

Name: ______________________ ID: B

## Other

### USING SCIENCE SKILLS

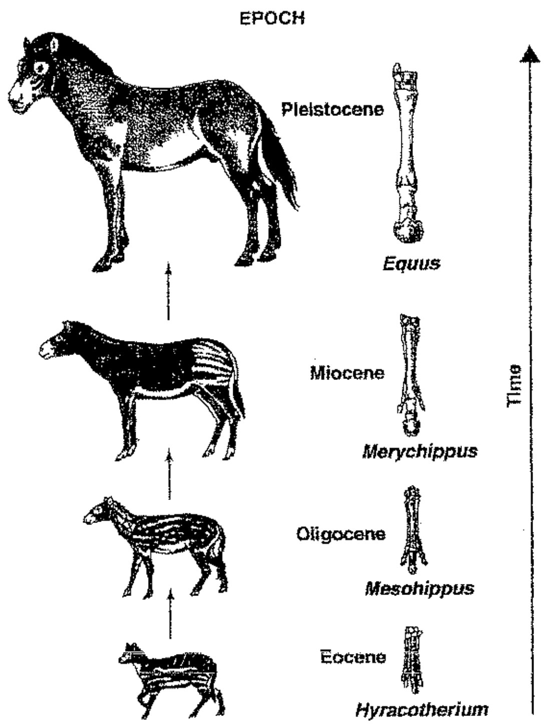


Figure 15–3

36. **Interpreting Graphics** According to Figure 15-3, how did the body size of the horse change during its evolution?

37. **Inferring** Scientists have never seen the ancient horses shown in Figure 15-3. What do you think was the main type of evidence that scientists used to prepare these diagrams?

38. **Comparing and Contrasting** According to Figure 15-3, how does the number of toes of Mesohippus compare with those of Equus, the modern horse?

Name: ____________________ 

## USING SCIENCE SKILLS

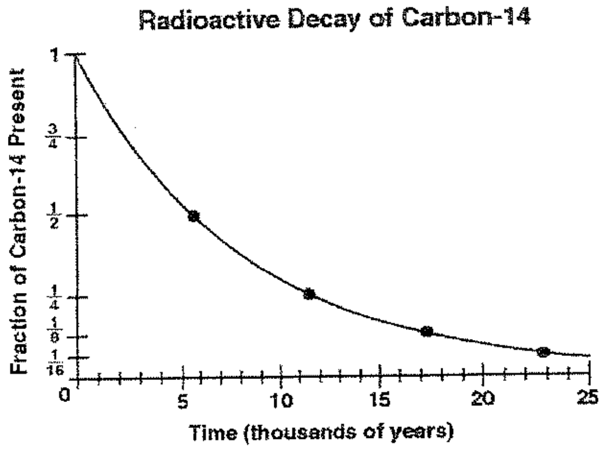


**Figure 17–1**

39. **Using Tables and Graphs** According to Figure 17-1, how many half-lives have passed if a fossil has 1/8 of its original amount of carbon-14?

40. **Using Tables and Graphs** A fossil bone was found to contain about 1/16 of the amount of carbon-14 that was originally present. Use Figure 17-1 to determine the approximate age of the bone.

41. **Inferring** According to Figure 17-1, in which case would carbon-14 be more useful for dating: wooden beams in Native American cave dwellings, which probably are less than 7000 years old, or the fossil of an early mammal that is probably almost 100,000 years old? Explain your answer.

Name: ______________________ Class: __________________ Date: _________ ID: A

# Miller-Urey

## Other

### USING SCIENCE SKILLS

Figure 17–3 shows a version of Stanley Miller and Harold Urey's apparatus used to simulate what was thought to be conditions on early Earth.

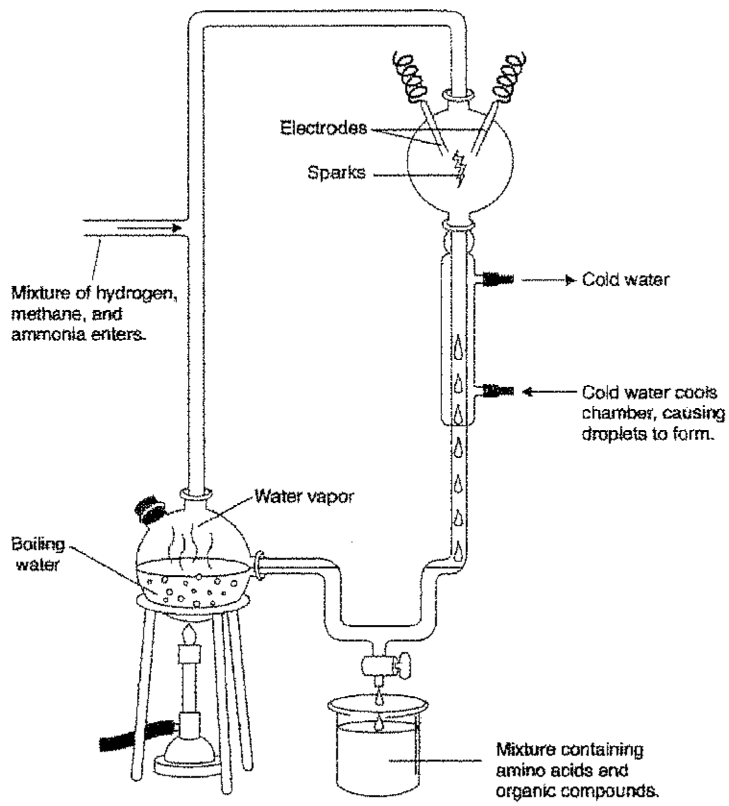


**Figure 17–3**

1. **Inferring** In the apparatus in Figure 17–3, what do the electrodes produce and what does that simulate?

2. **Inferring** In Figure 17–3, what is the purpose of combining the water vapor and the mixture of gases?

3. **Drawing Conclusions** In the experiment in Figure 17–3, what conclusions can be drawn from the mixture that was collected in the container on the bottom?

Name: ________________________ Class: ___________________ Date: __________ ID: B

# Chapter 18 Classification

**Multiple Choice**
*Identify the letter of the choice that best completes the statement or answers the question.*

____ 1. Biologists use a classification system to group organisms in part because organisms
a. are going extinct.
b. are very numerous and diverse.
c. are too much alike.
d. share too many derived characters.

____ 2. The study of organisms requires the use of
a. only small, specific categories of organisms.
b. only large, general categories of organisms.
c. both large and small categories of organisms.
d. no categories of organisms.

____ 3. Scientists assign each kind of organism a universally accepted name in the system known as
a. the three domains.
b. cladistics.
c. traditional classification.
d. binomial nomenclature.

____ 4. In taxonomy, a group at any level of organization is referred to as a
a. cladogram.
b. taxon.
c. binomial.
d. system.

____ 5. Scientists have identified and named
a. all living and extinct species.
b. all living species.
c. a fraction of all species.
d. all extinct species.

____ 6. In the scientific version of a species name, which of the terms is capitalized?
a. the second term only
b. the first term only
c. both the first and second terms
d. neither the first nor the second term

____ 7. Based on their names, you know that the baboons *Papio annubis* and *Papio cynocephalus* do NOT belong to the same
a. family.
b. genus.
c. class.
d. species.

____ 8. How do binomial, or two-part, names compare with early versions of scientific names?
a. They are shorter.
b. They are longer.
c. They are completely descriptive.
d. They are in English.

____ 9. The second part of a scientific name is unique to each
a. species in its genus.
b. order in its class.
c. genus in its family.
d. family in its order.

____ 10. Before Linnaeus, scientific names were problematic because they were
a. written only in Greek.
b. very long and difficult to standardize.
c. written only in Latin.
d. too brief to be descriptive.

____ 11. In Linnaeus's system of classification, how many taxonomic categories were there?
a. one
b. five
c. seven
d. three

____ 12. A genus is composed of a number of related
a. phyla.
b. orders.
c. kingdoms.
d. species.

Name: ________________________ ID: B

____ 13. Several different classes make up a
   a. kingdom.
   b. family.
   c. genus.
   d. phylum.

____ 14. Which two kingdoms did Linnaeus recognize?
   a. plants and animals
   b. protists and animals
   c. plants and fungi
   d. bacteria and animals

____ 15. The most general and largest category in Linnaeus's system is
   a. the kingdom.
   b. the phylum.
   c. the genus.
   d. the domain.

____ 16. What does a cladistic analysis show about organisms?
   a. the order in which derived characters evolved
   b. the general fitness of the organisms analyzed
   c. the relative importance of each derived character
   d. all traits of each organism analyzed

____ 17. What does the presence of similar genes in very dissimilar organisms imply?
   a. The organisms share a common ancestor.
   b. The genes became identical through mutation.
   c. The organisms do not share a common ancestor.
   d. The genes were produced by different selection pressures.

____ 18. All organisms in the kingdoms Protista, Plantae, Fungi, and Animalia are
   a. multicellular organisms.
   b. prokaryotes.
   c. eukaryotes.
   d. photosynthetic organisms.

____ 19. Which of the kingdoms in the six-kingdom system of classification was once grouped with plants?
   a. Carnivores
   b. Fungi
   c. Animalia
   d. Protista

____ 20. Some scientists propose that the kingdom Protista should be broken up into several kingdoms. Which of these statements accurately supports this idea?
   a. Protista evolved before any other kingdom.
   b. Protista contains very diverse organisms that do not fit into the other kingdoms.
   c. Protists are the most numerous organisms on Earth.
   d. Protists are all very similar and easy to confuse.

____ 21. The domain that corresponds to the kingdom Eubacteria is
   a. Eukarya.
   b. Archaea.
   c. Bacteria.
   d. Fungi.

____ 22. The domain that contains unicellular organisms that live in extreme environments is
   a. Archaea.
   b. Bacteria.
   c. Eubacteria.
   d. Eukarya.

____ 23. The two domains composed of only unicellular organisms are
   a. Archaea and Eukarya.
   b. Eubacteria and Archaea.
   c. Archaea and Bacteria.
   d. Eukarya and Bacteria.

____ 24. The three-domain system recognizes fundamental differences between two groups of
   a. protists.
   b. eukaryotes.
   c. multicellular organisms.
   d. prokaryotes.

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**Other**

**USING SCIENCE SKILLS**

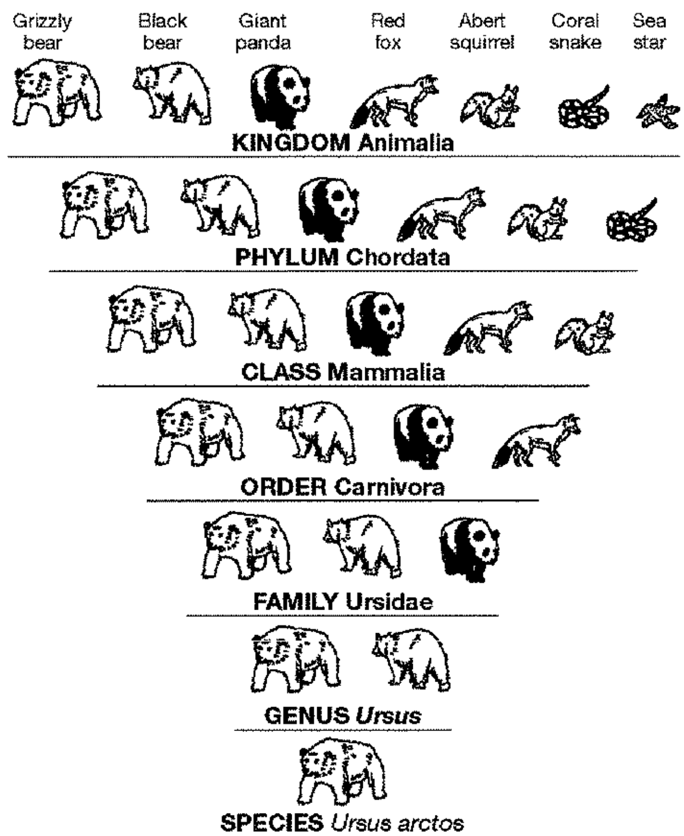


**Figure 18–2**

25. **Interpreting Graphs** Which level of taxonomic category shown in Figure 18–2 contains the greatest number of different organisms?

.

26. **Classifying** Do all organisms shown in Figure 18–2 that belong to the order Carnivora also belong to the phylum Chordata?

.

27. **Classifying** Do all organisms shown in Figure 18–2 that belong to the class Mammalia also belong to the genus *Ursus*?

.

28. **Observing** Based on the information in Figure 18–2, describe how the diversity at each level changes from species to kingdom.

.

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USING SCIENCE SKILLS

**Classification of Living Things**

| DOMAIN | Bacteria | Archaea | Eukarya | | | |
|---|---|---|---|---|---|---|
| KINGDOM | Eubacteria | Archaebacteria | Protista | Fungi | Plantae | Animalia |
| CELL TYPE | Prokaryote | Prokaryote | Eukaryote | Eukaryote | Eukaryote | Eukaryote |
| CELL STRUCTURES | Cell walls with peptidoglycan | Cell walls without peptidoglycan | Cell walls of cellulose in some; some have chloroplasts | Cell walls of chitin | Cell walls of cellulose; chloroplasts | No cell walls or chloroplasts |
| NUMBER OF CELLS | Unicellular | Unicellular | Most unicellular; some colonial; some multicellular | Most multicellular; some unicellular | Multicellular | Multicellular |
| MODE OF NUTRITION | Autotroph or heterotroph | Autotroph or heterotroph | Autotroph or heterotroph | Heterotroph | Autotroph | Heterotroph |
| EXAMPLES | *Streptococcus*, *Escherichia coli* | Methanogens, halophiles | *Amoeba*, *Paramecium*, slime molds, giant kelp | Mushrooms, yeasts | Mosses, ferns, flowering plants | Sponges, worms, insects, fishes, mammals |

**Figure 18–3**

29. **Using Tables and Graphs** According to Figure 18–3, what is the main difference between the domain Bacteria and the domain Archaea?

30. **Applying Concepts** If you know an organism has a cell wall and is a multicellular autotroph, could you use Figure 18–3 to determine the kingdom to which it belongs? Why or why not?

31. **Applying Concepts** If you were told only that an organism is unicellular and has chloroplasts and a nucleus, could you use Figure 18–3 to determine the kingdom to which it belongs? Why or why not?

32. **Using Tables and Graphs** Considering the data presented in Figure 18–3, which characteristic seems more important in assigning an organism to a specific domain—the presence or absence of a nucleus or its mode of nutrition? Why?

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USING SCIENCE SKILLS

**Classification of Four Organisms**

| | **Corn** | **Whale Shark** | **Humpback Whale** | **Spider Monkey** |
|---|---|---|---|---|
| **Kingdom** | Plantae | Animalia | Animalia | Animalia |
| **Phylum** | Anthophyta | Chordata | Chordata | Chordata |
| **Class** | Monocotyledones | Chondrichthyes | Mammalia | Mammalia |
| **Order** | Commelinales | Squaliformes | Cetacea | Primates |
| **Family** | Poaceae | Rhincodontidae | Balaenopteridae | Atelidae |
| **Genus** | Zea | Rhincodon | Megaptera | Ateles |
| **Species** | *Zea mays* | *Rhinacodon typus* | *Megaptera novaeangilae* | *Ateles paniscus* |

**Figure 18–4**

33. **Using Tables and Graphs** Which two organisms listed in Figure 18–4 are most closely related to each other? Explain.

34. **Using Tables and Graphs** Which level of taxonomic category shown in Figure 18–4 indicates whether an organism is a mammal or not?

35. **Using Tables and Graphs** How many different kingdoms are represented by the organisms listed in Figure 18–4? What are they?

36. **Inferring** If you were adding a column to Figure 18–4 for the protist species *Amoeba proteus*, what taxonomic category, if any, would be the same as for any of the organisms shown in Figure 18–4? Explain.

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