

Investigating Models of Evolution

One of the major difficulties with evaluating evolution is that the fossil record is incomplete. In this activity you will investigate two models of evolution.

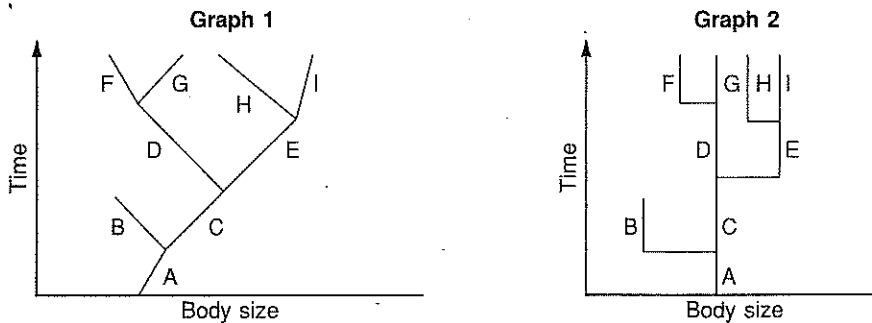
Charles Darwin proposed the theory of natural selection to explain evolution. He said that species change gradually over time. These small changes eventually resulted in new species. Most scientists agree with Darwin's theory, but questions are still raised about parts of the theory.

One of the most important questions involves the rate of evolution. If Darwin's theory of gradualism is correct, you would expect to see a range of slightly varying fossils leading from one species to the next. However, the fossil record shows few intermediate forms. Some scientists explain the gaps in the fossil record by pointing out that few organisms become fossils and it is likely that there are no fossils of many species.

Some scientists explain the gaps in the fossil record another way. These scientists support the theory of punctuated equilibria, which explains that the gaps in the fossil record are gaps in evolution. They believe that there are few intermediate forms as species evolve. Instead, species remain unchanged for millions of years, then undergo rapid evolution.

The figure below illustrates two alternative ways of interpreting the same fossil data about body size. Each straight line that is labeled with a letter stands for a species. Angles indicate the points at which species diverged from an older species, forming new ones. The greater the angle between two species, the greater the difference in body size. Label the graphs to show which one illustrates punctuated equilibria and which one illustrates gradualism.

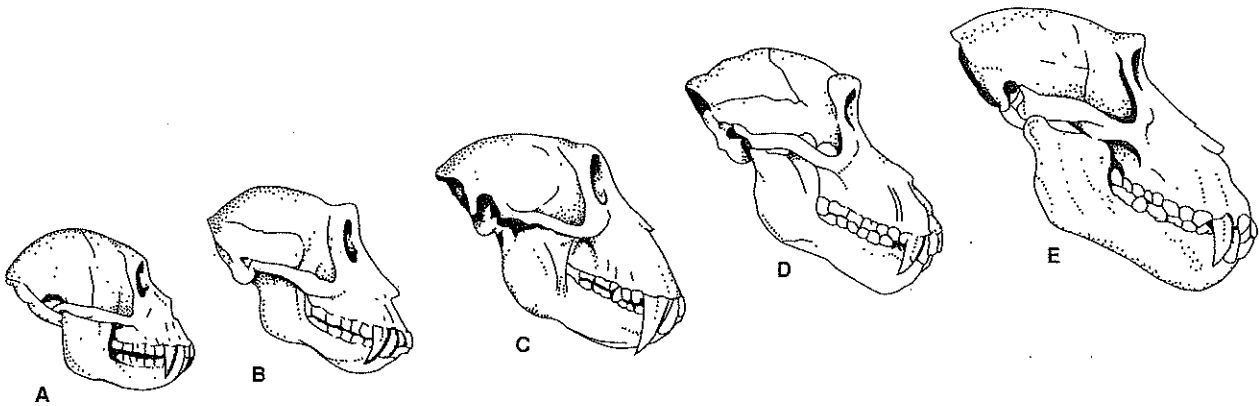
Evolution of New Species



1. In what ways are the two interpretations similar and in what ways are they different?

2. Imagine that a new fossil has been found from the time period between species A and species B as shown in Graph 1. What prediction would you make about the size of the new fossil? Explain your answer.

Below are skulls from five different species. Use them to answer the questions that follow.



3. Use the theory of gradualism to explain the transitions between species A and species E.

4. How would you explain the same sequence using the theory of punctuated equilibrium?

Evolution: How Change Occurs

VOCABULARY REVIEW

Cross-a-Clue

1. survival 2. divergent 3. gradualism 4. convergent
 5. Darwin 6. population 7. niche 8. artificial
 9. genes 10. natural selection 11. adaptive radiation
 12. extinction 13. relative 14. equilibrium 15. speciation

SKILL ACTIVITIES

Finches in the Galapagos

1. (Sample answers) *Cacti*: long beaks to reach into-flowers for nectar; thick beaks to crack open the fruit of cacti; long pointed beaks to remove the ticks from iguanas. *Tropical trees*: long beaks to peck wood in order to reach tree insects; large beaks to break open fruit or to catch flying insects. *Moist forest*: thick beaks to crack seeds; large beaks to break open fruit. *Treeless zone*: long beaks to poke the ground for insects. 2. (Sample answers) *Cacti*: ground nests made with ground plant material. *Tropical trees*: tree nests made with underbrush and tree material. *Moist forest*: tree nests made with tree leaves, twigs, and underbrush material. *Treeless zone*: ground nests made with ground plant material. 3. a. The shortest length of the beak is 6 mm to 7 mm b. about 2 percent 4. The beak length of 45 percent of the birds of species A is about 8 mm. 5. Most of the birds of species B have beaks of 12.5 mm to 13 mm. 6. The range is from 16 mm to 22.5 mm. 7. Species A probably eats small seeds. Species B can eat seeds larger than those eaten by species A. Species C can probably eat seeds that are larger than those eaten by either species A or species B.

Making a Model Molecular Clock

Figure 2, 1–2 *Turtle*: Positions—11, 12, 15, 33, 36, 44, 46, 50. Number—8. Percentage of Difference—16%. *Shark*: Positions—9, 11, 12, 15, 22, 33, 44, 46, 50. Number—9. Percentage of Difference—18%. *Fruit fly*: Positions—9, 11, 12, 13, 15, 22, 28, 36, 44, 46, 47, 50. Number—12. Percentage of Difference—24%. **Figure 4** Reptiles—0.064; Fishes—0.045; Insects—0.044; Average—0.051 3. 37.74 percent 4. 40.8 percent 5. The clock allows the estimation of dates when carbon dating or other means cannot be used because no physical evidence has been found.

Investigating Models of Evolution

Graph 1 should be labeled gradualism; Graph 2 shows punctuated equilibria. 1. They both start with species A and end with branches of species F, species G, species H, and species I. The changes in both graphs occur over the same amount of time. The difference between the two graphs is that the transition from one letter to another in Graph 1 shows a gradual but regular change over time. In Graph 2 the transition is quick but then remains constant for a long period. Also, species A, species C, species D, and species G in Graph 2 seem to be one long-lived species. But in Graph 1, although the same body size is at-

tained at the end, gradual change occurred along the way. 2. It would be intermediate in body size between species A and species B because Graph 1 indicates a steady and gradual change in body size from species A to species B. 3. The skulls that are pictured show gradual change in size and shape from A to E. These changes probably took place at an even pace. 4. This theory would assume that the differences between the skulls occurred rapidly followed by a period of little, if any, evolutionary change.

LABORATORY WORKSHEET

Simulating Natural Selection

Observations 1. Fifty percent of the beans were lima beans, fifty percent of the beans were kidney beans. 2. Yes. The lima beans were removed more frequently. 3. The frequency of lima beans decreased over five generations. The frequency of kidney beans increased over five generations. 4. The total number of beans left increased in each generation. **Analysis and Conclusions** 1. The kidney beans represent the beneficial genes in the population. The lima beans represent the harmful genes in a population. At the end of the investigation the lima beans have been removed from the population. 2. Organisms with harmful genes are selected against and removed from the population. Thus, more of the individuals in the remaining population have the beneficial genes. 3. They tend to be selected against and removed from a population. **Critical Thinking and Application** 1. As the percentage of harmful genes decreases, the population increases. 2. This model supports natural selection by showing that selecting between existing variations causes the percentage of beneficial variations to increase. 3. Harmful dominant genes are weeded out by selection more quickly than harmful recessive genes because harmful recessive genes are not expressed in hybrid individuals and are therefore not selected against in hybrids.

CHAPTER TEST B

Multiple Choice 1. b 2. a 3. c 4. d 5. b 6. b 7. c 8. d 9. d 10. a **Completion** 1. analogous 2. survival of the fittest 3. gene frequency 4. population 5. divergent **True or False** 1. T 2. F, camouflage 3. T 4. T 5. F, natural selection **Using Science Skills** 1. stabilizing selection 2. disruptive selection 3. directional selection 4. directional selection **Essays** 1. Lamarck was among the first to set forth an evolutionary theory. He believed that organisms changed because of a desire to better themselves—that change occurred because an organism could alter its shape by using their bodies in new ways and these acquired traits could be passed on. Darwin's experiences led him to believe that evolution occurred through natural selection, which he explained in terms of overproduction, struggle for existence, and survival of the fittest. With the discovery of genes, evolution is now explained in genetic terms. Genes are considered to be the source of random variation upon which natural selection operates. Most recently, the the-

Evolution: How Change Occurs

Multiple Choice Choose the letter of the answer that best completes each statement.

1. A scientist who proposed that evolution resulted from the inheritance of acquired characteristics was
 - a. Charles Lyell.
 - b. Thomas Malthus.
 - c. Theodore Dobzhansky.
 - d. Jean Baptiste de Lamarck.
2. The fossil record indicates that several times in the past, huge numbers of species have disappeared suddenly in a phenomenon known as
 - a. speciation.
 - b. divergent evolution.
 - c. convergent evolution.
 - d. mass extinction.
3. Evolution does not occur unless something upsets a population's
 - a. genotype.
 - b. phenotype.
 - c. genetic equilibrium.
 - d. camouflage.
4. Divergent evolution is also known as
 - a. adaptive radiation.
 - b. speciation.
 - c. genetic recombination.
 - d. survival of the fittest.
5. A reason why two species of birds in the same area might not breed with each other is that they
 - a. have different courtship behavior.
 - b. occupy the same niche.
 - c. lack behavioral barriers.
 - d. are geographically isolated.
6. Farmers change the gene pool of a population by
 - a. artificial selection.
 - b. adaptive radiation.
 - c. natural selection.
 - d. convergent evolution.
7. In the artificial selection of cows for better milk, breeders choose cows with desirable
 - a. gene frequencies.
 - b. mutations.
 - c. variations.
 - d. acquired traits.
8. All the individuals of the same species in a given area form a
 - a. gene pool.
 - b. niche.
 - c. phenotype.
 - d. population.
9. The fact that most maple seeds never grow into mature trees is in keeping with
 - a. artificial selection.
 - b. Lamarck's explanation of evolution.
 - c. the Malthusian doctrine.
 - d. Lyell's observations.
10. The controversial theory proposed to explain gaps in the fossil record is
 - a. gradualism.
 - b. punctuated equilibria.
 - c. natural selection.
 - d. inheritance of acquired traits.

11. The success of an organism in passing on its genes is a definition of
a. fitness. b. adaptation. c. speciation. d. radiation.
12. The combination of an organism's habitat and its role in that habitat is called a
a. population. b. gene pool. c. fitness. d. niche.
13. Similar organisms that breed with each other and produce fertile offspring in the natural environment make up a
a. gene pool. b. species. c. niche. d. population.
14. All the members of a population share
a. acquired traits. c. no alleles.
b. relative frequencies. d. a gene pool.
15. New species usually form only when populations
a. have similar gene pools. c. are isolated.
b. have genetic drift. d. are in adjoining niches.
16. Kettlewell's study of peppered moths provides an example of Darwin's principle of
a. overproduction. c. survival of the fittest.
b. artificial selection. d. genetic interaction.
17. The evolution of one-hump and two-hump camels is probably the result of
a. convergent evolution. c. divergent evolution.
b. genetic drift. d. adaptation.
18. Natural selection is also known as
a. overpopulation. c. survival of the fittest.
b. speciation. d. genetic isolation.
19. A new species will have a good chance of surviving if it
a. occupies an empty niche. c. shares a niche.
b. leaves a niche. d. destroys a niche.
20. The evolution of Darwin's finches is an example of
a. equilibrium. c. speciation.
b. artificial selection. d. species passing on acquired traits.
21. Many types of dinosaurs occurred as the result of
a. extinction. c. convergent evolution.
b. overlapping niches. d. adaptive radiation.
22. A random change in a gene frequency is known as
a. gene pool. b. genetic drift. c. variation. d. fitness.
23. Two sources of genetic variation are mutations and
a. gene recombination. c. analogous structures.
b. mass extinction. d. homologous structures.
24. The horseshoe crab, *Limulus*, is an example of a (an)
a. extinct organism. c. living fossil.
b. poor survival. d. slow adaptation.
25. Evolutionary change is a (an)
a. assumption. c. collection of hypotheses.
b. fact. d. debatable opinion.

The correct answers for the student chapter test are filled in. You may want to hole punch the correct answers and place your answer key over the student answer sheet for easy grading. Or you may want to use the column of correct answers that appear beside each question.

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CHAPTER 15

Classification Systems
Section 15-1

SKILL ACTIVITY
Analyzing data

Fun with Fictitious Animals

A good classification system will assign a single name to each organism and place organisms into groups that have real biological meaning. Researchers using a good classification system can expect members of a group to share important characteristics.

Read over the following taxonomic, or classification, key that describes ten fictitious animals. Using the information given in the key, answer the questions that follow.

A Taxonomic Key

1	A. Body covered with hair	Go to 2
	B. Body covering is not hair	Go to 6
2	A. Has four legs	Go to 3
	B. Has more than four legs	Go to 4
3	A. Has two heads and two tails	Double Trouble
	B. Has one head and a short bushy tail	Grenabar
4	A. Has one horn on its head	Tamboro
	B. Has two horns on head	Go to 5
5	A. Has wheels for feet	Skateroo
	B. Has feet with three sharp claws	Dweezle Bub
6	A. Body covered with scales	Go to 7
	B. Body covered with feathers	Go to 8
7	A. Has flippers for its six feet and tail	Nessie
	B. Has pincers for its six feet and has a long forked tail	Marfwheelzel
8	A. Has beak with no teeth	Go to 9
	B. Has mouth with sharp teeth	Tearitup
9	A. Has two antennae and short tongue	Quib
	B. Has four antennae and long tongue	Ork

- A tamboro is most like a
 - bird.
 - fish.
 - mammal.
 - reptile.
- Where would a nessie be most likely to live?
 - desert
 - ocean
 - forest
 - meadow
- How many legs does a dweezle bub have?
 - two
 - three
 - four
 - more than four
- What kind of body covering does an ork have?
 - feathers
 - hair
 - scales
 - none

5. Which animal is most like a real animal?
a. double trouble b. skateroo c. grenabar d. marfwheel
6. What color is a dweezlebug?
a. red b. brown c. green d. cannot tell from key
7. Which animal is most likely to be able to climb trees?
a. dweezlebug b. nessie c. skateroo d. ork
8. Describe what a quib looks like.

9. Draw a picture of a skateroo, including all of its characteristics mentioned in the key.
10. Draw a picture of one of the animals and see if a friend can guess which one you have drawn.

CHAPTER 15

Classification Systems
Section 15-2

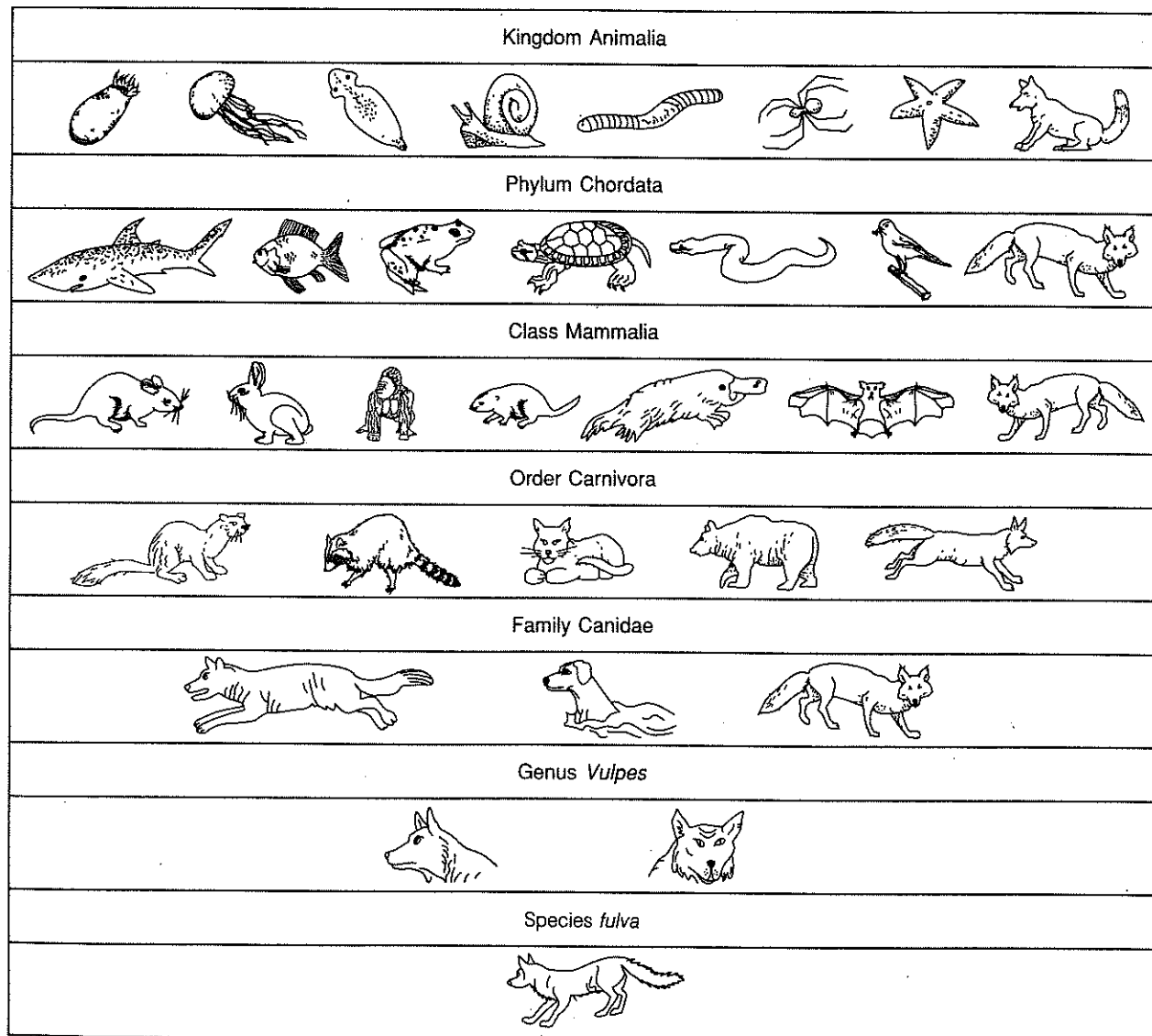
SKILL ACTIVITY
Identifying relationships

Analyzing Relationships Within a Classification System

The living world shows great diversity. There are a large number of different organisms, and each species has characteristics that are different from the others. In this activity you will identify and analyze the structure of a commonly used classification system.

The figure below shows a scheme used to classify animals.

Figure 1



1. List the common features of the animals in each group. _____

2. Describe the major differences between each group. For example, the decision to classify an organism in either kingdom or phylum is that some animals have a spinal cord and others do not.

Phylum-Class _____

Class-Order _____

Order-Family _____

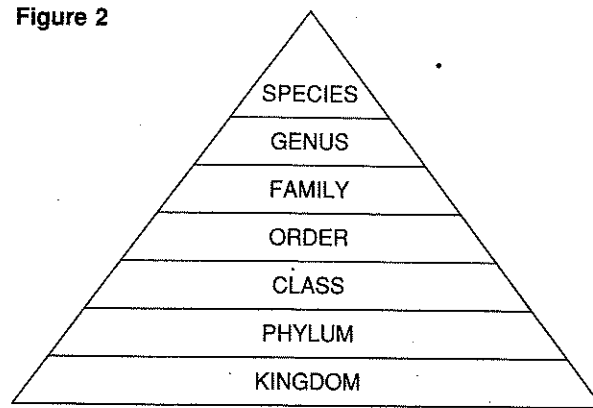
Family-Genus _____

Genus-Species _____

3. Describe what happens to the degree of diversity at both ends of the scheme, from the higher taxonomic levels to the lower taxonomic levels. _____

Classification systems have been represented by various models. The pyramid in Figure 2 is an example. It can be used to illustrate various aspects of the structure of a system, such as the number of organisms per level. Use this as a guide to draw a pyramid that includes the organisms shown in Figure 1.

Figure 2



4. Venn diagrams can also be used to make models of classification schemes. A Venn diagram is shown in Figure 3. Four groups are represented by circular regions—A, B, C, and D. Each region represents a collection of things or members of a taxonomic level. Regions that overlap, or intersect, share common members. Regions that do not overlap do not have members in common. Use the following terms to label the regions shown in Figure 3: *All Animals*; *Animals That Have Backbones*; *Insects*; *Mammals*.

Figure 3

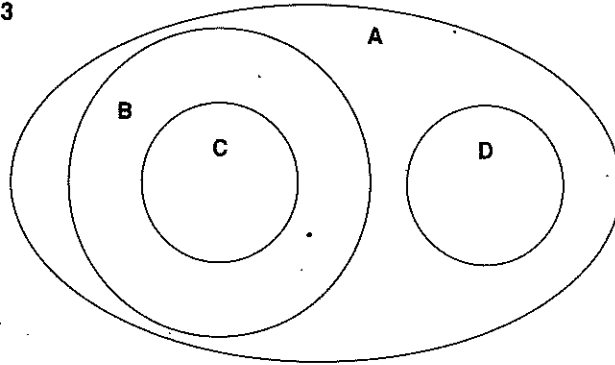


Figure 4 shows a classification scheme for butterflies (family, genus, and species have been omitted).

Kingdom	Animalia
Phylum	Arthropoda
Class	Insecta
Order	Lepidoptera

- 5. On a separate sheet of paper, construct a Venn diagram that models the information contained in Figure 4.
- 6. Do any of the regions intersect or overlap? If so, describe the pattern.

Classification Systems

VOCABULARY REVIEW

Word Game

1. hemoglobin
 2. kingdom
 3. fungi
 4. carnivora
 5. family
 6. Linnaeus
 7. taxa
 8. class
 9. monera
 10. taxonomy
 11. animalia
 12. species
 13. plantae
 14. cytochrome c
 15. phylum
 16. canidae
 17. protista
 18. genus
 19. rubrum
 20. order
- Answer**
binomial nomenclature

SKILL ACTIVITIES

Fun with Fictitious Animals

1. c
2. b
3. d
4. a
5. c
6. d
7. a
8. A qujb has feathers, a beak, no teeth, two antennae, and a short tongue.
9. should include hair, two horns, more than four legs, wheels for feet
10. Drawings will vary.

Analyzing Relationships Within a Classification System

1. Kingdom—multicellular heterotrophs; Phylum—spinal cord; Class—fur or hair; Order—meat eating; Family—doglike; Genus—body size, shape of muzzle; Species—fur color
2. Phylum—Class: some animals are warm-blooded and have fur; other animals are coldblooded and lack fur. Class—Order: some mammals eat plants; others eat meat; others eat both kinds of food. Order—Family: some animals have legs; others have flippers. Family—Genus: body size, bushiness of tail, and shape of muzzle differ. Genus—Species: coloration of fur and size of ears differ.
3. Students' pyramid should show that the degree of diversity decreases from the higher to the lower levels.
4. A is labeled *All Animals*. B is labeled *Animals That Have Backbones*. C is labeled *Mammals*. D is labeled *Insects*.
5. Check student diagrams.
6. Beginning with the order Lepidoptera, each region (group) is contained in the next largest level.

LABORATORY WORKSHEET

Preparing a Collection of Organisms

- Observations**
1. Protista and Monera
 2. All organisms are made of cells. Plants, animals, and fungi are multicelled. Plants have chlorophyll and can make their own food. Animals and fungi do not have chlorophyll and can-

not make their own food. Monera and protists are single-celled. Monera lack a nucleus.

3. It was probably easiest to find plants; microscopic organisms were the most difficult to find.

Analysis and Conclusions

1. The actual organisms are too small to be easily seen as part of a display.
2. Some organisms seem to have characteristics of organisms in two different kingdoms. Some organisms are too small to be easily classified. Accept other logical answers.

Critical Thinking and Application

1. The *Euglena* gets food like a plant and like an animal. It also moves like an animal. The five kingdom system classifies the *Euglena* as a protist and not as an animal or a plant because it is one celled.
2. Sponges should be classified as animals because they filter food from the environment.
3. The single-celled green algae and the multi-celled green algae have the same pigments. This biochemical similarity shows an evolutionary relationship.

CHAPTER TEST B

- Multiple Choice**
1. a
 2. b
 3. b
 4. d
 5. d
 6. b
 7. a
 8. c
 9. a
 10. c
- Completion**
1. Mammalia
 2. evolutionary theory
 3. Chordata
 4. microorganisms
 5. binomial nomenclature
- True or False**
1. F, prokaryote
 2. T
 3. F, prokaryotes
 4. T
 5. F, Mammalia
- Using Science Skills**
1. Monerans are prokaryotic; all other organisms are eukaryotic.
 2. heterotrophic
 3. Animalia
 4. Protista
- Essays**
1. Both organisms must be in the same genus because both scientific names begin with the term *Felis*. The different second name shows that they are in different species.
 2. The new type of wheat was developed by cross-breeding. Organisms will interbreed only within the same species. Tritium, therefore, must be a species.
 3. As taxonomists learn more about the organism's biologically important characteristics, they may move the organism to another taxon.
 4. Scientists use structural characteristics and biochemical relationships in adults and embryos to classify animals. In fossils, only skeletal structures can be used for classification. Embryologic structures and biochemical molecules are not usually preserved.
 5. These organisms are important examples of the intermediary steps in evolution that can be used to link modern groups of organisms.

Classification Systems

Multiple Choice Choose the letter of the answer that best completes each statement.

1. The scientific name for humans is written
a. *Homo Sapiens*. b. *Homo sapiens*. c. *homo sapiens*. d. Homo Sapiens.
2. The smallest taxon is
a. kingdom. b. order. c. phylum. d. species.
3. Unlike a plant, a plantlike protist
a. is unicellular. c. uses mitochondria.
b. has a nucleus. d. contains chloroplasts.
4. An animal that is warmblooded, has hair, and produces milk for its young must be in the
a. order Primate. c. Order Carnivora.
b. class Mammalia. d. class Panthera.
5. The two organisms whose DNA and RNA are most similar in structure are
a. humans and chimpanzees. c. cats and dogs.
b. roses and oak trees. d. mosses and ferns.
6. A eukaryotic organism that has a cell wall that lacks cellulose is a (an)
a. plant. b. animal. c. fungus. d. protist.
7. In the present system of taxonomy, the least clear-cut division of kingdoms is between the
a. protists and the multicellular kingdoms.
b. monerans and the protists.
c. plants and the fungi.
d. fungi and the animals.
8. Any moneran contains a
a. chloroplast. c. nucleus.
b. cell membrane. d. mitochondria.
9. Any good classification system does not
a. show relationships.
b. reveal evolutionary trends.
c. use different scientific names for the same organism.
d. change the taxon of an organism based on new data.
10. The double-naming system introduced by Linnaeus is
a. based solely on Greek names.
b. known as binomial nomenclature.
c. not used for microorganisms.
d. used only for eukaryotes.
11. The third smallest taxon in the Linnaeus system of classification is the
a. phylum. b. order. c. class. d. family.

12. Solely from its name, you know that *Rhizopus nigricans* must be
 a. a plant. c. in the species *nigricans*.
 b. an animal. d. in the family *Rhizopus*.
13. In classifying organisms, orders are grouped into
 a. classes. b. phyla. c. families. d. genera.
14. Cats, dogs, and lions are in the
 a. family Felidae. c. order Carnivora.
 b. family Canidae. d. class Chordata.
15. The only taxon with a clear biological identity is the
 a. genus. b. phylum. c. class. d. species.
16. If a one-celled organism contains membrane-enclosed organelles, it must be a (an)
 a. protist. c. plantlike protist.
 b. animallike protist. d. funguslike protist.
17. Carnivores are
 a. primates. c. meat eaters.
 b. in two genera. d. plant eaters.
18. The unifying biological principle in modern classification systems is
 a. biological characteristics. c. cellular structure.
 b. evolutionary theory. d. binomial nomenclature.
19. Not all members of the genus *Felis* have similar
 a. feet. c. body sizes.
 b. claws. d. teeth.
20. The taxon that includes all the others is
 a. Mammalia. c. Primate.
 b. Chordata. d. Carnivora.
21. From fossil evidence, scientists believe that the earliest life forms on Earth were
 a. eukaryotes. c. animals.
 b. prokaryotes. d. plants.
22. An organism that lacks mitochondria and reproduces by binary fission is a (an).
 a. animallike protist. c. fungus.
 b. funguslike protist. d. moneran.
23. An organism whose separate cells are not divided by complete cell walls is in the kingdom
 a. Animalia. c. Fungi.
 b. Plantae. d. Protista.
24. It became clear that Linnaeus's two kingdoms could not be used to classify all organisms after the discovery of
 a. viruses. c. microorganisms.
 b. monerans. d. protists.
25. To show evolutionary relationships, taxonomists do not use
 a. analogous structures in young people.
 b. homologous structures in adults.
 c. homologous structures in embryos.
 d. homologous structures in fossils.

The correct answers for the student chapter test are filled in. You may want to hole punch the correct answers and place your answer key over the student answer sheet for easy grading. Or you may want to use the column of correct answers that appear beside each question.

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The Origin of Life

Multiple Choice Choose the letter of the answer that best completes each statement.

1. Spontaneous generation is a
a. fact. b. theory. c. hypothesis. d. law.
2. To demonstrate that spontaneous generation could occur under proper conditions, Needham
a. placed nutrient broth in an open bottle and heated it.
b. sealed nutrient broth in a bottle and heated it.
c. placed gravy in an open bottle and heated it.
d. sealed gravy in a bottle and heated it.
3. It is reasonable to propose that the Earth's atmosphere developed from a combination of
a. steady rain and meteorites. c. volcanic activity and steady rain.
b. meteorites and volcanic activity. d. comets and volcanic activity.
4. An extremely important step in the evolution of eukaryotic life was
a. the formation of the nucleus.
b. the formation of hydrogen sulfide.
c. sexual reproduction.
d. asexual reproduction.
5. In Stanley Miller's experiments with the origin of life forms, ultraviolet light was used to
a. simulate the temperature. c. sterilize the gases.
b. simulate sunlight. d. simulate lightning.
6. Which step is not part of Carin-Smith and Bernal's hypothesis to explain how the first true cells arose?
a. Attractive forces concentrate amino acids.
b. Attractive forces concentrate nucleic acids.
c. Proteins were formed on the surfaces of clay crystals.
d. DNA replicated itself from droplets.
7. Scientists have proven that meteors, comets, and the dust in the universe contain
a. organic molecules. b. liquid water. c. ATP. d. free oxygen.
8. The modern form of photosynthesis changed life on Earth because it released into the atmosphere
a. CO₂. b. O₂. c. H₂O. d. H₂S.
9. One reason spontaneous generation cannot occur today is that today's Earth
a. enhances natural selection among organisms.
b. enhances sexual reproduction.
c. contains bacteria that utilize hydrogen sulfide.
d. contains bacteria that break down organic compounds.
10. After the evolution of sexual reproduction, evolving life forms crossed another evolutionary threshold with the development of
a. unicellular organisms. c. metabolic pathways.
b. multicellular organisms. d. photosynthesis.

11. The first true cells were not
 - a. prokaryotes.
 - b. heterotrophs.
 - c. aerobes.
 - d. anaerobes.
12. In about 500 million years, photosynthesis transformed the Earth into a (an)
 - a. heterotrophic planet from an autotrophic planet.
 - b. autotrophic planet from a heterotrophic planet.
 - c. aerobic planet from an anaerobic planet.
 - d. anaerobic planet from an aerobic planet.
13. Francisco Redi did not believe that
 - a. adult flies lay eggs.
 - b. maggots become adult flies.
 - c. eggs develop into maggots.
 - d. maggots arise spontaneously.
14. The Earth's atmosphere probably developed about
 - a. 4.6 billion years ago.
 - b. 4 to 4.2 billion years ago.
 - c. 3.8 to 4 billion years ago.
 - d. 3.5 billion years ago.
15. People who still doubted Spallanzani's results argued that spontaneous generation could not occur without
 - a. water.
 - b. air.
 - c. meat.
 - d. broth.
16. Evidence that indicates when oceans formed on the Earth comes from the dating of
 - a. sedimentary rock.
 - b. ocean water.
 - c. microfossils.
 - d. the atmosphere.
17. In experiments related to the Earth's organic "soup," Oparin and Fox found that some molecules collected into tiny round droplets that
 - a. reproduce but do not grow.
 - b. grow but do not reproduce.
 - c. neither grow nor reproduce.
 - d. both grow and reproduce.
18. Several scientists have proposed that the first cells formed near volcanic vents
 - a. in tidal pools.
 - b. in land volcanoes.
 - c. beneath the ocean.
 - d. on high mountaintops.
19. A scientist who believed in spontaneous generation was
 - a. Spallanzani.
 - b. Redi.
 - c. Pasteur.
 - d. Needham.
20. Early photosynthesis probably involved the use of
 - a. hydrogen sulfide.
 - b. water.
 - c. acetic acid.
 - d. lactic acid.
21. Outlines of ancient cells that are preserved well enough to identify them as prokaryotes are
 - a. microfossils.
 - b. stromatolites.
 - c. autotrophic.
 - d. phototrophic.
22. The ozone layer is important because it
 - a. produces ultraviolet radiation.
 - b. absorbs ultraviolet radiation.
 - c. destroys aerobic organisms.
 - d. destroys anaerobic organisms.
23. Fossil evidence indicates that stromatolites were the first successful
 - a. autotrophs.
 - b. heterotrophs.
 - c. prokaryotes.
 - d. eukaryotes.
24. When Pasteur prepared his flasks with long, curved necks, he did not
 - a. leave the necks open to the air.
 - b. use nutrient broth in the flasks.
 - c. seal the necks of the flasks.
 - d. boil the contents of the flasks.
25. Most scientists agree that the Earth's first atmosphere did not contain
 - a. hydrogen cyanide.
 - b. hydrogen sulfide.
 - c. nitrogen.
 - d. oxygen.

The correct answers for the student chapter test are filled in. You may want to hole punch the correct answers and place your answer key over the student answer sheet for easy grading. Or you may want to use the column of correct answers that appear beside each question.

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