NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 50 MINS

Exploring Vertebrate Classification

Students group vertebrates and share their reasoning in classifying them. They compare their approach to Linnaean and modern systems in order to explore evolutionary relationships and the dynamic nature of classification.

GRADES

9 - 12+

SUBJECTS

Biology, Geology

CONTENTS

1 PDF

OVERVIEW

Students group vertebrates and share their reasoning in classifying them. They compare their approach to Linnaean and modern systems in order to explore evolutionary relationships and the dynamic nature of classification.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/exploring-vertebrate-classification/

Program

FLYING MONSTERS with DAVID ATTENBOROUGH

DIRECTIONS

1. Discuss the purpose of classification.

To gauge students' prior knowledge of biological classification, ask: *Why classify Earth's living things?* Accept a variety of ideas, and guide students to consider that classification helps us sort out ancestor/descendent relationships and allows us to map the evolutionary history of living things. For example, the presence or absence of characteristics can help you know how a population of organisms is related or can guide in investigating the evolutionary history of them.

2. Relate the Linnaean system to evolutionary relationships.

Students will likely be familiar with the Linnaean system, named for the Swedish scientist Carl Linnaeus, who developed the system in the 18th century. They should be familiar with its hierarchy: kingdom, phylum, class, order, family, genus, species. Ask: *How do you think organisms are classified into specific categories in the Linnaean system?* Explain that the classification of living things is based on the number of shared characteristics. Those organisms with the greatest number of shared characteristics are most closely related. Two organisms' relatedness reflects how recently they diverged from a common ancestor. All living things are related evolutionarily if you go back in time far enough. Ask students to think about characteristics that humans, apes, and chipmunks have in common, and list them on the board. Ask: *Which do you think is more closely related to humans, the great ape or chipmunk?* (Humans and great apes are more closely related.) *How do you think this explains their relationship to ancestors?* (Both diverged relatively recently from a common primate ancestor; humans and chipmunks diverged in the more distant past from a common mammal ancestor.) Explain that humans currently reside in the family Hominidae with the great apes, and both share space in the class Mammalia with the chipmunks. The first mammal, in turn, separated from modern-day reptiles still earlier from an ancient reptile that is the ancestor of both. Reptiles and mammals belong—along with fish, birds, and amphibians—in the phylum Chordata. All the chordates, in turn, belong to the kingdom Animalia, along with every insect, mollusk, and worm.

3. Prepare for the classification activity.

Explain that, in this activity, students will group animals based on shared characteristics, and by doing this they will attempt to determine evolutionary relationships. Organize students in groups of three, and give each group a poster-sized sheet of butcher paper, removable tape or glue, scissors, and colored markers. Provide each group with the handout A Grouping Challenge. Have them cut each of the 19 boxes, descriptions of key anatomical and behavioral characteristics for 19 vertebrates.

4. Have students create five to nine vertebrate groups.
Have each group read the descriptions and consider how they might group these in as few as five or as many as nine groups. Ask students to mark with colored dots or highlight the shared characteristics they think are important in classification. For example, students might mark with a color each instance of "warm-blooded" or "feathers" to help with arranging visually. Explain that the goal is not to get a right answer, but instead to develop their own explanation for how they would divide these into groups with shared characteristics that seem most closely related. Discourage the groups from applying names to the groupings, such as mammals or reptiles; it is best if they try to classify them strictly according to their characteristics rather than relying on prior knowledge of how the classification is supposed to be. Have students tape or glue their groupings to the butcher paper and write a short explanation of why they grouped in the way they did.

5. Evaluate the different classification schemes.
Have students present their posters or do a poster walk to view the various grouping explanations. Ask: *How similar or different are the classification schemes? Which do you think is closest to how scientists currently classify these animals? Why?* Next, list on the board these categories of features that scientists have determined are most indicative of common ancestry: skin covering, warm/cold-bloodedness, skeletal features and anatomy, and methods of reproduction. Have students look at the vertebrate descriptions again, and have them circle any characteristics that fall into these four categories. Groups can reconsider their original groupings now that they have this new information. Poll the class on how many groups they now have.

6. Share the Linnaean classification and more recent approaches.
Traditional Linnaean classification placed these animals in five groups: fish, amphibians, reptiles, birds, and mammals. Share the numbers and names below:

- **Fish**: 2—bluefish, 3—blue shark, 8—lungfish
- **Amphibians**: 5—blue-spotted salamander, 7—mudpuppy, 16—caecilian, 19—green frog
- **Reptiles**: 4—ichthyosaur, 6—blue racer, a snake, 11—pterosaurs, 12—*Tyrannosaurus rex*, 17—leatherback turtle, 18—blue-tailed skink, a lizard
- **Birds**: 9—blue penguin, 10—bluebird, 15—blue duck
- **Mammals**: 1—blue whale, 13—gray bat, 14—duck-billed platypus

Tell students not to worry if they had six or more groups, as today these vertebrates are grouped with more complexity and scientists continue to debate classification issues. Scientists can further analyze evolutionary relationships with technology that enables analysis of DNA. Fish are now usually separated into 3 separate classes: Chondrichthyes or cartilaginous fishes (the blue shark), Actinopterygii or ray-finned bony fishes (bluefish), and Dipnoi (lungfishes). Reptiles traditionally have included snakes, turtles, lizards, and crocodilians, as well as pterosaurs and dinosaurs. Today, turtles, crocodilians, and snakes and lizards are often put into three separate classes. Prehistoric "reptiles" are more confusing still. *Tyrannosaurus rex* may be closer to birds than reptiles, considering its skeleton and the strong possibility that it might have been warm-blooded and even had feathers in one stage of its development. Recently, scientists have even been able to extract proteins from *Tyrannosaurus* fossils that further support the idea that these gigantic beasts might actually have been more bird than modern amphibian. Birds, in fact, might better be considered as a subgroup of reptiles. Pterosaurs might have been warm-blooded with a fur-like skin covering unlike any present-day reptile.

7. Discuss the challenges of classification.
Have students compare their approaches to the classification schemes unveiled in step 6. Ask: *Did you originally consider characteristics that were not one of these four: skin covering, warm/cold-bloodedness, skeletal features and anatomy, and methods of reproduction? Explain*. Discuss the past and present challenges that taxonomists have faced in classifying the vast array of living things.

Extending the Learning

Today, scientists more commonly use a system called cladistics for classification, which is considered to reflect evolutionary relationships more accurately than the traditional Linnaean system. Have students research how paleontologists use this classification approach for pterosaurs or other organisms.

OBJECTIVES

Subjects & Disciplines

Biology
Earth Science
- Geology

Learning Objectives

Students will:

- describe criteria scientists use to classify vertebrates
- explain that classification is based on common characteristics and evolutionary ancestry
- discuss challenges and opportunities with classification today

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Hands-on learning
- Inquiry

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
    - Critical Thinking and Problem Solving
- Critical Thinking Skills
  - Analyzing
  - Applying
  - Understanding

National Standards, Principles, and Practices

NATIONAL SCIENCE EDUCATION STANDARDS

• **(9-12) Standard A-2:**
Understandings about scientific inquiry
• **(9-12) Standard C-3:**
Biological evolution

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Butcher paper
- Colored markers
- Pens
- Removable tape or glue
- Scissors

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Small-group instruction

BACKGROUND & VOCABULARY

Background Information

Animals are classified according to how closely they are related evolutionarily, meaning how recently they diverged from a common ancestor. Determining evolutionary relationships is not straightforward, though, because evolution can result in living things that are not closely related sharing similar characteristics. For example, a variety of fish, birds, mammals, reptiles, and amphibians are blue, but this color similarity does not mean that these animals are closely related. The role of the taxonomist is to determine which features of a living thing reflect

common ancestry. Today DNA analysis plays a large role in classifying living things, and an approach to classification called cladistics, which shows organisms' common ancestry, has replaced the traditional Linnaean approach to classification.

Prior Knowledge

["classification", "evolution"]

Recommended Prior Activities

- Adaptive Radiation
- Examining Convergent Evolution

Vocabulary

Term	Part of Speech	Definition
classification	*noun*	grouping based on physical and genetic characteristics.
evolution	*noun*	change in heritable traits of a population over time.
taxonomy	*noun*	study of the identification, classification, and naming of organisms.

For Further Exploration

Websites

- National Geographic Entertainment: Flying Monsters 3D