

RESOURCE LIBRARY | ACTIVITY : 1 HR

Microbes Across the Tree of Life

Students explore how scientists classify living organisms, then gather information about five of the main categories of microbes: bacteria, viruses, fungi, protozoa, and algae, and contrast the term *microbes* with systems of scientific classification to show how it is distinct and that microbes are found across the tree of life.

GRADES

5 - 9

SUBJECTS

Biology, Health

CONTENTS

2 PDFs

OVERVIEW

Students explore how scientists classify living organisms, then gather information about five of the main categories of microbes: bacteria, viruses, fungi, protozoa, and algae, and contrast the term *microbes* with systems of scientific classification to show how it is distinct and that microbes are found across the tree of life.

For the complete activity with media resources, visit:

<http://www.nationalgeographic.org/activity/microbes-across-tree-life/>

In collaboration with



DIRECTIONS

1. Elicit students' ideas about how to classify and organize living organisms through a card sort activity.

- Ask students:
 - *What kinds of items do you organize or classify around the house, at school, or for sports or hobbies?*
 - *Why is it important to you to have those items organized?*
- As students share their answers, keep track of their ideas in a visible place.
- Connect student ideas to scientific classification by asking:
 - *Why is it important for scientists to classify and organize organisms? (Students' answers will vary, but may include: having common terms to talk about the same organism, designate endangered species, understand broader patterns of how organisms are related to each other.)*

Explain that students will decide on their own system of classification for living organisms through the Critter Card Sort.

- Pass out a set of Critter Cards to pairs or small groups of students.
 - Organisms to include: manatee, hyrax, elephant, *E. Coli.*, yeast, protozoa, algae, orchid, fern, earthworm, ant, sea star, kangaroo, lizard, snake, sea nettle, frog, eagle, crab, mouse, salmon, dog, lobster, and clam.
- Prompt students to use the guidelines below as they create groups for the organisms on the cards:
 - Any kind of criteria can be used to form groups (for example legs/no legs), as long as all members agree on the grouping criteria.
 - Each grouping should be given a name.
 - Students should be prepared to explain their classification and naming system, and what features or criteria they used for grouping the organisms.
- After students have decided on their organism groupings, prompt them to share with another partner or group; elicit a few groups to share with the whole class.

2. Project the tree of life from the [OneZoom Tree of Life Explorer](#) to show how scientists have organized all living organisms based on their evolutionary relationships.

- Zoom in and out of the tree to see different organisms and how they are grouped together on the tree.
- Ask students to point out what they notice about organisms that are close together on the tree versus far apart.
- Explain that the tree of life is one system of organizing organisms, both living and extinct, via fossil evidence. The groupings are based on scientists' understanding of how closely related the organisms are, using evidence from the organisms' anatomical features and, if possible, their genetic information (DNA and RNA).
 - Organisms that are hypothesized to be closely related are found close together on the tree because they share a recent common ancestor.
- Ask students:
 - *How is the tree of life organization similar to or different from the grouping systems you used in the Critter Card Sort?*
 - *How did you use anatomical features in your sort?*

3. Introduce the Linnaean system of scientific classification and explain how it is also based on the manner in which living organisms are related.

- Zoom out on the [OneZoom Tree of Life Explorer](#) to show the group names on the branches, such as eukaryotes.
 - Clicking on the name will show the scientific name, the number of species, and pictures of representative species.
- Explain that in addition to visually showing how organisms are related, scientists also use the tree of life to give names to groups of organisms. For example, Eukaryota represents one of the main three groupings of organisms: domains.
- Introduce the rest of the groupings under the Linnaean classification system, emphasizing how the naming system is hierarchical. Walk through a representative example to show how one organism concurrently belongs to multiple groups, such as a Western terrestrial garter snake (*Thamnophis elegans*):
 - Domain: Eukaryota
 - Kingdom: Animalia
 - Phylum: Chordata
 - Class: Reptilia
 - Order: Squamata
 - Family: Colubridae

- Genus: *Thamnophis*
- Species: *elegans*
- Point out to students that Linnaean terms are in Latin, to standardize naming and communication about organisms across the world.

Apply the Linnaean system to the Critter Cards and microbes:

- Return to OneZoom and use the search box in the top right corner to locate some of the organisms on the Critter Cards.
 - Show how the elephant, hyrax, and manatee are each other's closest relatives.
 - Show the representative microbes on the Critter Cards (Bacteria: *Escherichia coli*, Protozoa: *Blepharisma japonicum*, Algae: *Dunaliella viridis*) to demonstrate how microbes are spread across the tree of life.
- Refer to the scientific names that were on the Critter Cards and ask students to identify the level of grouping that is referred to (genus and species).
- Review the definition of *microbes* from the [Introduction to Microbes and Human Body Systems](#) activity: organisms that cannot be seen with the naked eye.
- Prompt students to compare this type of definition to the Linnaean system of classification by asking:
 - *How is the term microbes similar to and different from the Linnaean system of scientific classification?* (Possible responses: Similar because both are based on physical characteristics that are shared by organisms; different because many types of organisms are microscopic, it does not clarify if organisms are related to each other.)

4. To facilitate making connections to the focal organisms for the Misunderstood Microbes unit, prompt students to learn more about five of the main groups of microbes.

- Explain that students will work with a partner to engage with the [Microbe Passports](#) online interactive, which introduces five of the six main groups of microbes: bacteria, viruses, fungi, protozoa, and algae.
- Distribute and review the Introducing Microbes Note Tracker for students to keep track of their thinking and respond to synthesis questions that help students to connect microbes to scientific classification. Note that students need to *hunt* for the types of microbes listed on their Note Tracker, but may use the additional spaces for any others that they are interested in recording.

- Lead a debrief discussion. Use students' responses to the synthesis questions on the tracker to solidify students' understanding that microbes are found across the entire tree of life.

Revisit the class *Know and Need to Know* chart for students to see how their thinking and understanding about microbes is already changing since the previous lesson. What questions can move from the *Need to Know* to the *Know* column?

Modification

Step 2: Have students explore the tree of life in more detail by opening OneZoom Tree Explorer on individual or partner computers.

Tip

Step 2: Tip for navigating the OneZoom Tree Explorer: From the OneZoom main page, Explore tab, choose one of the groupings below to automatically zoom into the "tips" of the tree and show organisms with which students are more familiar:

- Vascular plants
- Birds
- Amphibians
- Mammals
- Apes

Modification

Step 3: Have students re-sort the Critter Cards based on Linnaean taxonomy, either as a whole class or using the OneZoom Tree Explorer on individual or partner computers.

Modification

Step 3: To illustrate how the tree of life is organized into three domains, show the first 2:20 minutes of the video [Exploring Deep-Subsurface Life: Life Domains](#).

Modification

Step 4: Engagement with the online interactive could also be structured as a jigsaw activity, with each student group focusing on two to three of the microbes.

Informal Assessment

Use the final debrief discussion as a way to gauge students' understanding of the tree of life, scientific classification, and microbes. If following the *Misunderstood Microbes* unit, review students' notes and responses on the Introducing Microbes Note Tracker to prepare for the informal assessment at the end of the *Deep Dive into the Cell* activity.

OBJECTIVES

Subjects & Disciplines

Biology

- Health

Learning Objectives

Students will:

- Understand that microbial organisms are found across the entire tree of life.

Teaching Approach

- Project-based learning

Teaching Methods

- Discussions
- Multimedia instruction
- Reading

Skills Summary

This activity targets the following skills:

- Science and Engineering Practices

- Asking questions (for science) and defining problems (for engineering)
- Constructing explanations (for science) and designing solutions (for engineering)
- Developing and using models

National Standards, Principles, and Practices

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

- Reading Standards for Literacy in Science and Technical Subjects 6-12:

Integration of Knowledge and Ideas, RST.6-8.9

NEXT GENERATION SCIENCE STANDARDS

- MS. Biological Evolution: Unity and Diversity:

MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, 1 computer per pair, Monitor/screen, Printer, Projector

PHYSICAL SPACE

- Classroom

SETUP

In preparation for Step 2, load the [OneZoom Tree of Life Explorer](#) onto the class computer and zoom out so that the entire tree of life is visible. Practice using the explorer to navigate around the tree before you use it with students.

GROUPING

- Large-group instruction
- Large-group learning
- Small-group learning

BACKGROUND & VOCABULARY

Background Information

Scientists use physical characteristics and genetic information (i.e., DNA and RNA) to understand how organisms are related to each other, which they then use to create phylogenetic trees that depict these relationships. Organisms that are close to each other on a phylogenetic tree indicate that they have more recently shared a common ancestor and are more closely related to each other than organisms that are found farther apart on the tree. Scientists also use these patterns of evolutionary relatedness to classify all living organisms into groups using the Linnaean system of classification and binomial nomenclature. Since microbes represent multiple groups across the tree of life (including bacteria, archaea, protists, and fungi), the term microbes is not considered a scientific classification grouping. Additionally, viruses are a key group of microbes, but are not always considered to be living organisms given that they are not comprised of cells and can only survive and multiply within living organisms.

Prior Knowledge

["Organisms have different physical structures to support survival and reproduction.", "Organisms inherit traits from their parents.", "Organisms have unique life cycles, but all have in common birth, growth, reproduction, and death."]

Recommended Prior Activities

- [Introduction to Microbes and Human Body Systems](#)

Vocabulary

Term	Part of Speech	Definition
algae	<i>plural noun</i>	(singular: alga) diverse group of aquatic organisms, the largest of which are seaweeds.

Term	Part of Speech	Definition
anatomical features	<i>noun</i>	structure, form, or appearance of features relating to the body structure of organisms.
genus	<i>noun</i>	taxonomic category of structurally or phylogenetically related species.
Linnaean classification	<i>noun</i>	grouping based on physical and genetic characteristics following the methods of the Swedish botanist Carl Linnaeus.
organism	<i>noun</i>	living or once-living thing.
species	<i>noun</i>	group of similar organisms that can reproduce with each other.

For Further Exploration

Interactives

- [National Geographic: Vertebrate / Invertebrate Infographic](#)

Video

- [California Academy of Sciences: Discovering the Tree of Life](#)

Websites

- [Tree of Life Web Project](#)



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