GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

TEACHER GUIDE

CLASSIFICATION OF LIVING THINGS
GRADES 6–8

COMMON MISCONCEPTIONS

- **Only physical features are used to classify organisms.**
  Taxonomy uses many features that cannot be seen, such as DNA, to determine relationships between organisms.

- **The classification of organisms does not change.**
  As techniques improve for analysis of DNA, the classification of an organism can and does change.

- **Amphibians and reptiles are not vertebrates.**
  Many studies have shown that students at all levels correctly identify mammals and birds as vertebrates. However, students often fail to classify amphibians and reptiles as vertebrates or even animals.

TAXONOMY

All living things are divided into three groups, called domains, based on their genetic similarity. The three groups are as follows:

1. Archaea (archaebacteria): very ancient prokaryotic microbes. *Prokaryotic cells do not have a nucleus.*
2. Bacteria (eubacteria): more advanced prokaryotic microbes.
3. Eukarya (eukaryotes): all life forms with eukaryotic cells, including plants and animals. *Eukaryotic cells have a nucleus.*

The Eukarya domain is divided into groups called kingdoms (with examples):

- Kingdom Protista (slime molds, algae, protozoans)
- Kingdom Fungi (fungi, yeasts, molds)
- Kingdom Plantae (mosses, ferns, conifers, flowering plants)
- Kingdom Animalia (sponges, worms, insects, vertebrates)

Kingdoms can be further divided into smaller and smaller groups (physical and genetic similarities between organisms in the groups increase with each new division): phylum, subphylum, class, order, family, genus, species.

Organisms are named using both genus and species group names. *Homo* (genus) *sapiens* (species) is the scientific name for humans; *Canis lupus* is the scientific name for dogs, and so on.

DICHOTOMOUS KEYS

A dichotomous key is a way of identifying specimens based on contrasting statements, usually about physical characteristics. By drawing a series of contrasts, you can narrow down the specimen until you can correctly identify it. Dichotomous keys are often used in the sciences, such as biology and geology. To make your own dichotomous key, first select the characteristics you can use to contrast your specimens, then formulate these as a series of statements or questions you can use to narrow the classification down.

CLASSIFICATION AND PHYLOGENY

Taxonomy (which literally means *arrangement law*) is the science of naming and grouping species to construct an internationally shared classification system. The taxonomic classification system (also called the Linnaean system after its inventor, Carl Linnaeus, a Swedish naturalist) uses a hierarchical model. A hierarchical system has levels, and each group at one of the levels includes groups at the next lowest level so that at the lowest level each member belongs to a series of nested groups. (See Topic 1.)

Scientists use a tool called a phylogenetic tree to show the evolutionary pathways and relationships between organisms. A phylogenetic tree is a diagram used to reflect evolutionary relationships among organisms or groups of organisms. The hierarchical classification of groups nested within more inclusive groups is reflected in diagrams. Some of the names used for classification have been used in phylogeny, but many are different. Although this is not in the GG materials nor necessary for you to teach the specifics of this classification system, it is important to be aware of because your students may find this when they search for information to classify different organisms. Therefore, understanding differences between a taxonomic classification and a phylogenetic tree will be useful for clearing up confusion with respect to which name to use.

TEACHER TIPS

Some of the language used to describe the features of the different organisms is fairly technical. Specific names of bones are used. It may be helpful to project a skeleton of a human with the major bones labeled, so that students can refer to it. Help students realize that they can use context clues for many of the descriptions and figure out what bone is being referenced. When discussing parts of an organism or comparing parts, know what view is being used. Dorsal refers to the back side (vertebrae on top). Ventral refers to the belly side. Lateral means a side view. You may want to project this information for reference too.

Students need to use evidence from their data to support their claim for what taxonomic Class Seymouria belongs in. They will be quick to rule out some of the organisms based on size or even the view of the skeletons.

To help avoid this, make sure students have organized their data (they should set up a checklist, a matrix of traits, or some way to compare and look for patterns in several traits) and determined multiple criteria to examine (e.g., eye orbits, number/shape of vertebrae, occipital bone shape or fusion, fusion or not of tibia and fibula and of radius and ulna, presence or absence of ribs, number of ribs, articulation of joints of the forelimb and hindlimb). Ask students how confident they are in their claim. Students should conclude that the more evidence you have to support a claim, the more confident you can be. They should also note limitations of their analysis. For example, they had only pictures, not actual skeletons to compare. They have only the skeleton for the Seymouria and no other physical traits. They do not have any DNA for comparison. Scientists have debated whether the Seymouria is an amphibian or a reptile.

ABOUT THIS LESSON

This lesson was created by the National Science Teaching Association (NSTA) to pair with the Generation Genius video and support *NGSS*.

They have requested we provide the following background with this lesson:

The Next Generation Science Standards (NGSS) are the national standards on how students learn science, and they are based on contemporary research presented in *A Framework for K–12 Science Education (the Framework).* The shift in science teaching and learning required by the Framework is summarized in this infographic: A New Vision for Science Education.

At the start of each Generation Genius lesson, students are presented with a phenomenon, then they try to explain it. Students will notice they have gaps in their knowledge and ask questions, which motivates them to build ownership of science ideas they need in order to explain how or why the phenomenon occurred. The way students build ownership of science and engineering ideas is through active engagement in the science and engineering practices (SEPs). This process of sensemaking, or doing science to figure out how the world works, is one of the major shifts the *Framework* encourages.

To engage in the SEPs, students should be part of a learning community that allows them to share their ideas, evaluate competing ideas, give and receive critiques, and reach consensus. Students can start by sharing ideas with a partner, then with a small group, and finally, with the whole class. This strategy creates opportunities for all students to be heard, build confidence, and have something to contribute to whole-class discussions. Each Generation Genius lesson provides conversational supports to facilitate such productive student discussions to contribute to sensemaking.

Excited to continue your shift toward the new vision for science education? Check out the Generation Genius Teacher Guide page on the NSTA website for resources and strategies to engage every student in your classroom in **doing** science.