



## Activity Description and Estimated Class Time

Throughout the guide teaching tips are in red.

In this two class period activity, students sort a bag of hardware into groups of their own choosing and determine whether others can understand their system. In the process, they become familiar with what makes a classification system useful or difficult to use. They apply what they learned to the biological classification system, which uses comparative anatomy.

## Objectives

Students will develop an understanding of:

- How comparative anatomy can serve as the basis of a biological classification system.
- General rules that make classification systems effective.

## Correlations to North Carolina Science Standards

**8.L.4.1 Summarize the use of evidence drawn from geology, fossils, and comparative anatomy to form the basis for biological classification systems and the theory of evolution.**

## Brief Science Background for the Teacher

Biologists have developed a system for classifying living things into groups that reflect their evolutionary relationships. In the mid-1700s, Carl Linnaeus wrote a short manuscript (just 12 pages), *Systema Naturae*, in which he laid out a method for naming organisms. As he named more and more organisms he expanded his book and grouped the organisms in hierarchies. For example, he classified animals separately from plants. He grouped organisms based on physical similarities and differences. For example, mammals share more characteristics with each other than they do with snakes or spiders.

Linnaeus knew nothing about evolution, genetics, or DNA. Those concepts and discoveries were developed long after his death. However, his system was so sensible that biologists still use it today, although it has been refined and adjusted to reflect more detailed information about the living things on Earth.

## Day 1 – Sorting (50 minutes)

### Materials

#### Materials for the teacher

- Teacher supply bag of hardware
- Ability to project Black Line Master BLM-1 Sorting Rules
- Ability to project BLM-2 Master hardware inventory sheet

#### Materials for pairs of students

- 11" x 17" sheet of paper
- Student bag of hardware
- Science notebook
- 4" x 6" index card
- Hardware inventory sheet

**Procedure**

1. Have students form pairs. Supply each pair with a bag of hardware and one sheet of paper, 11" x 17."
2. Have each pair count the contents of their hardware bag and confirm that there are 24 items. Replace any missing items from the teacher supply bag.
3. Inform students that they will sort the hardware into groups on their paper. The sorting rules are as follows:
  - No group can have more than three items.
  - Each group must be labeled using clear and distinguishing characteristics.
  - All items must fit somewhere.
  - Each item should fit into only one group.
4. As students form groups on their paper, ask them to draw a circle around the group and write descriptive words to describe that group. Tell them that their description should leave no doubt as to which items go into that circle.
5. If possible, after each pair of students completes the sorting assignment have them take a picture using a cell phone to capture their results. If taking a picture is not possible, have students record their results in their science notebook.
6. Ask students to put all the hardware back into their bag.
7. Instruct pairs to swap papers. Hand each pair a blank 4" x 6" index card.
8. Ask pairs to sort the hardware based ONLY on the information provided on the paper. A pair cannot ask for help or clarification in sorting. When they finish, each pair can use the index card to give written feedback about how to make the sorting system easier to follow. For example, students might report which pieces of hardware were difficult to sort and why.
9. When both pairs are finished, ask them to share the index cards to discuss positive aspects of the grouping systems and ways to improve them.
10. Have students revise their systems based on feedback from their classmates.
11. At the conclusion of the activity, hand out a copy of the hardware inventory sheet and have students verify their bag has all 24 items. Replace any missing items from the teacher supply bag.

**Notebook / Discussion Prompts**

How did you and your partner go about forming groups?

Tip: **When students discuss comparing physical characteristics of hardware, connect this to comparative anatomy as a basis for biological classification.**

What were some of the difficulties in forming your groups?

What modifications did you make based on advice from your classmates?



## Day 2 – Test your system (50 minutes)

### Materials

#### Additional Materials, one for each pair of students

- New item #1, winged screw
- New item #2, T-nut
- BLM-3 Hardware Classification Example

### Procedure

1. Have students recreate their grouping system with the hardware on their paper.
2. Have each pair count the contents of their hardware bag and confirm there are 24 items. Replace any missing items from the teacher supply bag.
3. Explain that an additional hardware item was recently discovered and needs to be included in the system.
4. Give each pair new item #1, a winged screw.
5. Challenge each group to determine how the new item fits into their classification system. Allow students to modify their system if necessary to include it.
6. After all groups are done, lead a class discussion about how groups included the new item.
7. Repeat for item #2, a T-nut.
8. At the conclusion of this exercise point out that scientists are constantly adding to the biological classification system when new species are discovered. A more organized and clearly defined system makes it easier to do this.
9. Have students clear the hardware from their sheet and give each team a copy of BLM-3 Hardware Classification Example.
10. Explain that a scientist created this example of a classification system for this hardware. Have students sort the hardware using this classification system.
11. When finished have each student answer the notebook prompt in their science notebook. Afterward, lead a brief discussion based on their responses. Notebook prompt: What are some similarities and differences between the sorting system that you and your partner designed and the one that the scientist designed?  
**Students should notice the higher level of details of the system designed by the scientist. Students might also notice the hierarchical structure. This is an important quality of a classification system.**
12. Inform the students that we will test the new classification system (BLM-3) with a new item. Hand out item #1, the winged screw. Ask students to determine where this item fits best.



13. Have each pair share their results and describe how they determined where it fits.

**Students should notice that the winged screw fits in the “threaded stem, round head” lineage. At this point, students may discuss if the head has a slot or not, or if the new item requires modification to the classification system. Point out the advantages of the hierarchical system for classification.**

14. If your students are having difficulty understanding the advantage of a hierarchical system, present the Red Sprinkles dilemma as follows:

You are planning to make a cake for your mom and you realize that you need red sprinkles to decorate her cake but you do not have any in your house. Describe all the steps it would take to locate red sprinkles.

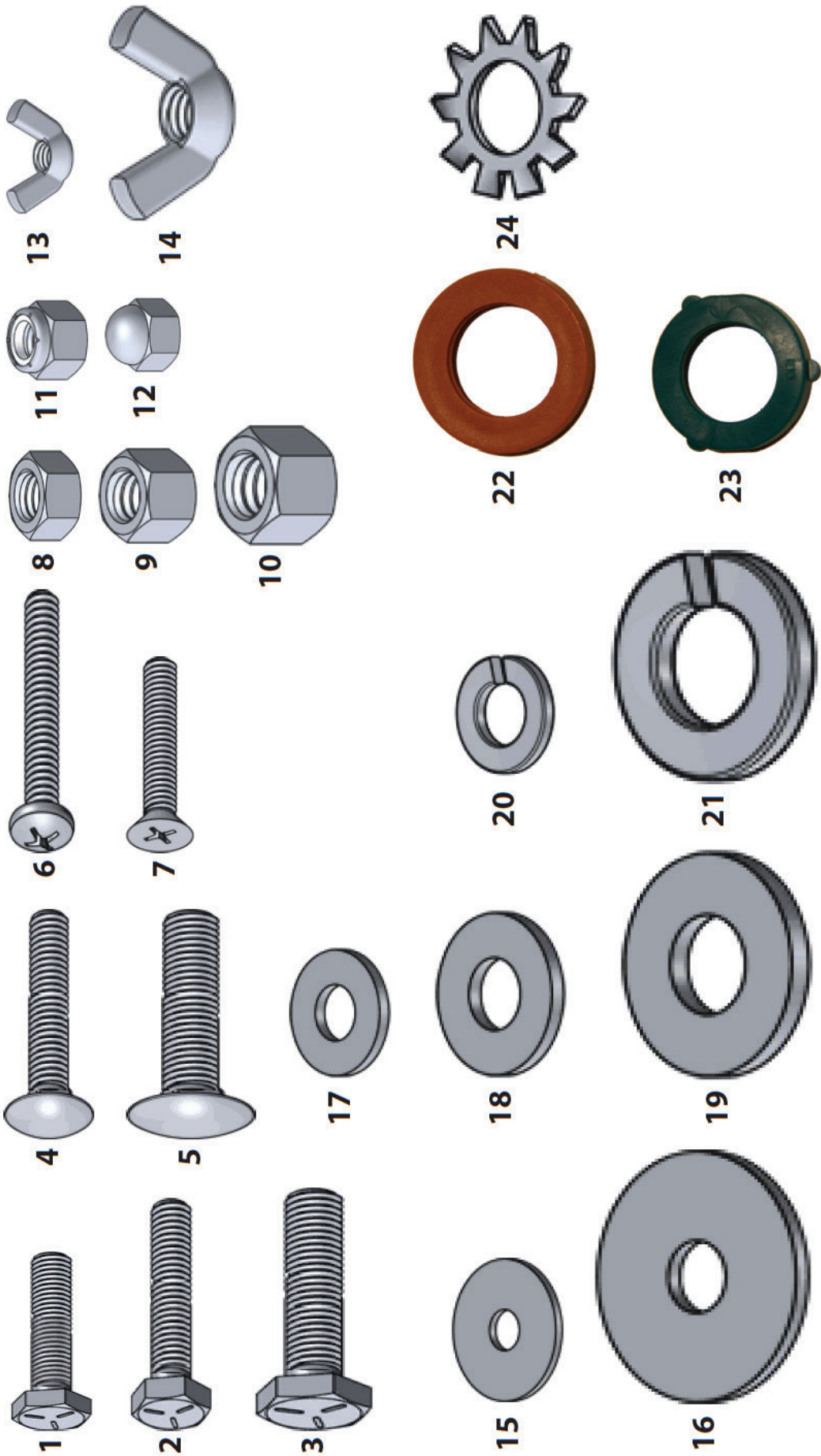
**Students will most likely say, go to the store. Ask “which store?” Continue to do this until they describe the exact location where they would expect to find red sprinkles. Here is an example:**

1. Store, Wal-Mart or Target.
2. Locate the grocery section of the store.
3. Locate the baking section within the grocery area.
4. Locate the decorating section within the baking section.
5. Find the sprinkles.
6. Find the red sprinkles.

**Point out the hierarchical structure in this example.**

15. Ask students to share other examples of hierarchical organization systems.
16. Repeat step 12 with item #2, a T-nut. Again, have students share where they think it fits and allow for debate. Point out that these debates are common in science as new species are discovered or new information becomes available.
- An example of new information is the ability to sequence the DNA of living organisms.
17. At the conclusion of the activity, hand out a copy of the hardware inventory sheet and have students verify their bag has all 24 items. Replace any missing items from the teacher supply bag.
18. Collect the two new items, winged screw and T-nut, and place them in their original bags. Be sure students do not include these new items with their student bag of hardware.

- No group can have more than three items.
- Each group must be labeled using clear and distinguishing characteristics.
- All items must fit somewhere.
- Each item should fit into only one group.



INSTRUCTIONS: Sort the 24 objects according to the descriptions in the diagram. The objects should be placed wherever there are ellipses:

