

# A Card-Sorting Activity to Engage Students in the Academic Language of Biology

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Sugar



Snake venom



EpiPen



Alcohol

Aspirin

## ABSTRACT

The activity described in this article is designed to provide biology students with opportunities to engage in a range of academic language as they learn the discipline-specific meanings of the terms “drug,” “poison,” “toxicant,” and “toxin.” Although intended as part of an introductory lesson in a comprehensive unit for the high school level, this approach to teaching academic language can be adapted for use with older or younger students and can be modified to teach other terms.

**Key Words:** academic language; Next Generation Science Standards; activity.

## Introduction

“Academic language” refers to specialized ways of communicating in academic contexts in general, and it also refers to specialized ways of communicating in specific disciplines (McComas, 2014). Biology has long been recognized as a discipline with demanding vocabulary (e.g., Wandersee, 1985; Yager, 1983), but the concept of academic language goes beyond learning vocabulary. It also includes learning the styles of talk that enable students to effectively communicate within the discipline (Lee et al., 2013).

Academic language plays a key role in recent U.S. standards documents, including the English Language Arts Common Core State Standards (ELA CC; CCSSO, 2010) and the Next Generation Science Standards (NGSS; NGSS Lead States, 2013). The ELA CC include standards for Science and Technical Subjects such as, “Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic” (CCSSO, 2010, para. 9). The NGSS are based on a framework that has as a main component an emphasis on engaging students in a range of science practices such as obtaining, evaluating, and communicating

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information (NGSS Lead States, 2013). Given the relevance of academic language in these recent standards documents, there is a need for examples of activities that are aligned with the standards. Therefore, we present an activity that goes beyond asking students to memorize vocabulary and instead engages them with opportunities to read, listen, speak, and write in a biological context.

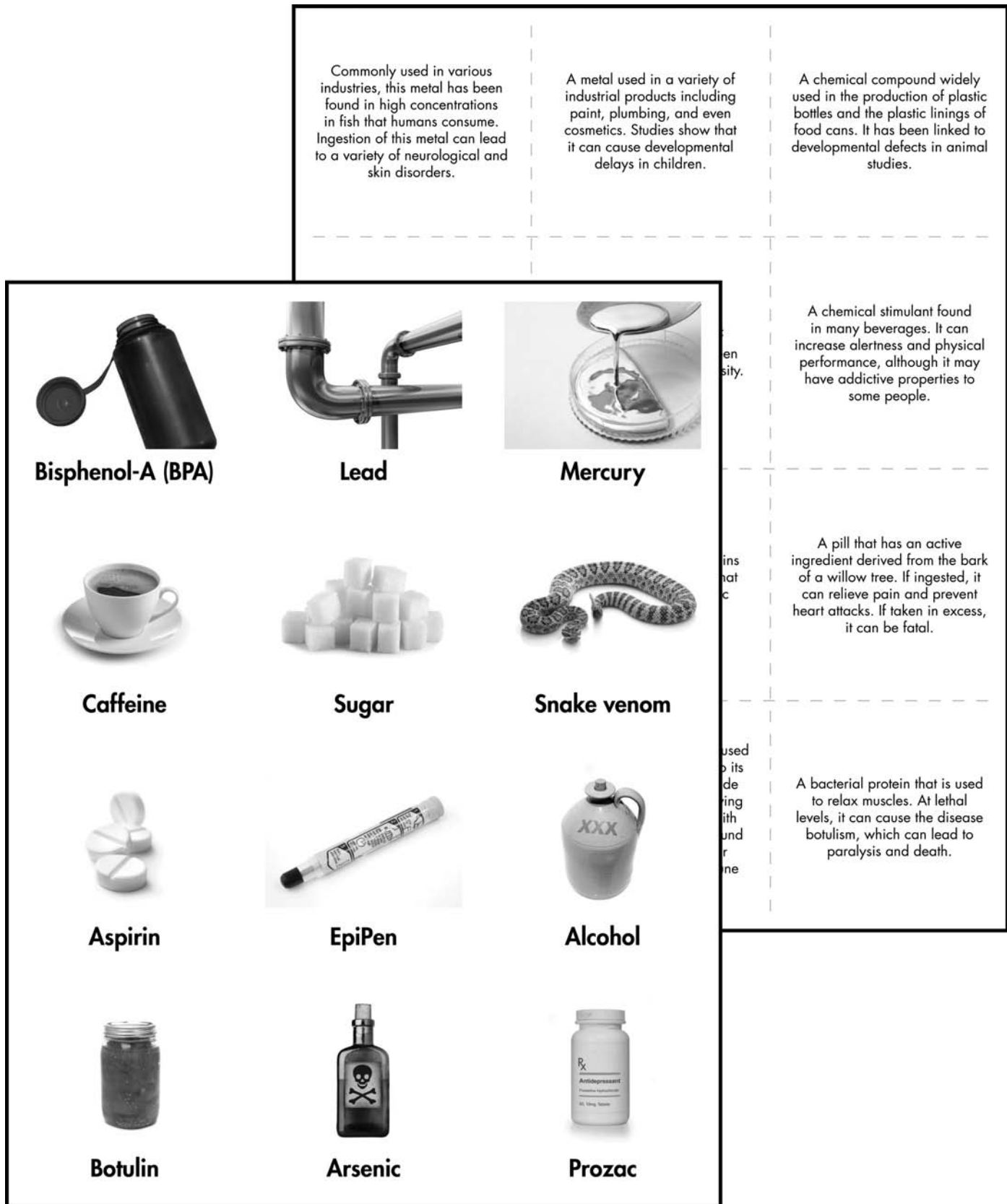
This activity comes from a lesson within the curriculum unit titled *What changes our minds? Toxicants, exposure, and the environment*. The unit was developed as part of Project NEURON, a NIH SEPA funded project (materials are freely available online at <http://neuron.illinois.edu>). During the unit, students explore how exogenous chemicals affect organisms in the context of authentic scientific research. Students do the activity early in the unit to learn the meaning of the terms “drug,” “poison,” “toxicant,” and “toxin” so that they can work with these concepts in depth throughout the unit. Although the activity was designed to be used within the whole curriculum unit, it can be used as an example for developing similar activities around academic language.

## Activity Learning Performance

- Identify patterns about substances classified as drugs, poisons, toxicants, and toxins, and evaluate and communicate that information.

## Required Materials

- Substance cards, 1 set of 24 cards per group (see Figure 1).
- Containers or envelopes labeled “drug,” “poison,” “toxicant,” and “toxin”; 1 set per group.
- Activity sheet, 1 per student.
- Stopwatch, 1 for teacher.



**Figure 1.** Twelve of the twenty-four substance cards before they are cut into individual cards. The fronts of the cards (left) have names of substances and a representative picture, and the backs of the cards (right) have brief descriptions of the substances.

- “Ask a Scientist” video clip (7:28).
- Video guide, 1 per student.
- Reading about drugs, poisons, toxicants, and toxins; 1 per student.

## ○ Activity Procedure

The activity takes place in four stages, as depicted in Figure 2. Below, we describe each stage and elaborate on why that stage is important for developing academic language.

### Stage A: Sort by Name (5 minutes)

1. Start the activity with a short discussion using the following questions:
  - What are some different substances that you come into contact with throughout the day?
  - How do you come into contact with these substances? Is your contact intentional or unintentional?
  - Do any of these substances change our minds? How do you think that can happen?
2. With students in groups of four, distribute substance cards, containers, and activity sheets. Groups will sort each substance card into one of four categories: drug, poison, toxicant, or toxin. During Stage A, students sort the cards into one of these categories using *only* the substance names, which are listed on the front of the cards (see Figure 1). Students have two minutes to quickly complete this task without looking at the back of the cards. Start the timer and tell students to begin. During this stage of the activity, circulate around the room and listen to conversations to assess students’ prior knowledge.
3. After two minutes, students stop and use their activity sheets to record how they classified each substance.
4. Have a brief discussion using the following questions as possible starting points:
  - What was your process for deciding the category to which each substance was sorted?
  - What disagreements about sorting did your group experience?
  - Which substances could fit into multiple categories? Why?

### Importance of This Stage

Students focus on speaking and listening as they provide justification to their peers for why a substance should be classified in a particular category. During this stage, students make connections to

everyday uses of the terms, and listening to students’ conversations enables assessment of their background knowledge about the substances and terms. This stage is designed to produce some disagreement about classifying the substances so that students see that some substances may be classified into multiple categories.

### Stage B: Sort by Description (20 minutes)

5. In their small groups, students shuffle the cards and place them face down so that the substance names are not visible. Rather than sorting the cards into four piles corresponding to the terms as they did during Stage A, students now sort the cards into two piles using *only* the descriptions found on the back of each card. The first pile should include cards with descriptions that lead students to answer “yes” to the following question, and the second pile should include cards that lead students to answer “no”:
  - Is this substance intentionally consumed, and can it alter your brain or behavior?

Students have five minutes to discuss and complete this task. This is another opportunity to circulate around the classroom to listen to student conversations.
6. After five minutes, students stop and use the activity sheet to record which cards they separated into each pile. Students flip over their pile of cards to see the names of the substances they separated into the “yes” pile, and they place a check in each corresponding box on the activity sheet. Students compare descriptions of all substances in their “yes” pile and reach a consensus on which term (i.e., drug, poison, toxicant, toxin) they think best represents the substances they selected.
7. Students repeat the procedure for Stage B three additional times, considering each of the following different questions:
  - Can this substance result in impairments or death of organisms?
  - Is this substance produced by an organism, and is it harmful to other organisms?
  - Upon exposure, does this substance have a harmful effect on an organism?

### Importance of This Stage

During this stage, students focus on reading descriptions of each of the substances and sorting the cards based on four different prompts. Again, they must speak and listen to one another in order to reach consensus on how to classify each card. During this stage, students continue developing an understanding that a substance may be classified in multiple ways.



**Figure 2.** Overview of the four stages of the activity.

**Stage C: Compare and Discuss Definitions (10 minutes)**

8. Students compare and discuss their group’s responses to the questions from Stage B with a member from another group. The activity sheet includes space for them to record their comparisons, and it includes questions to structure their discussions.
9. Once students have compared results for all four questions, lead a class discussion with the following questions:
  - How did reading the descriptions change your initial ideas of how the substances were classified?
  - How did responses compare across groups? What are examples of differences? Why do you think those responses differed?
  - What are characteristics of drugs? Poisons? Toxicants? Toxins?

The salient characteristics of each term are shown in Table 1.

**Importance of This Stage**

Not only do students continue to speak and listen in small group and whole group conversations, but students also write during this stage. This stage also involves evaluating information (part of a scientific practice in NGSS) and looking for patterns (a crosscutting concept in NGSS; NGSS Lead States, 2013).

**Stage D: Compare How Scientists Use the Terms**

10. Distribute the associated video guide to each student. Then play the “Ask a Scientist” interview video in which five scientists define “drugs,” “poisons,” “toxicants,” and “toxins” based on their discipline and training. Students use the video guide to scaffold their comparison of how they have used the terms in the previous stages with how the scientists use the terms in the video.
11. Distribute the reading about accepted definitions of “drugs,” “poisons,” “toxicants,” and “toxins.” Students answer the questions provided with the reading to help them reflect on how their use of the terms compares to accepted definitions.

**Importance of This Stage**

Students listen to scientists speak about the terms they have been discussing, and they also write responses to questions. Lastly, students read about definitions for the terms accepted by groups such as the Food and Drug Administration. The reading helps students continue to compare how different groups use the terms in different ways. During this stage students may be surprised to learn that the terms are used differently among scientists (e.g., an environmental

toxicologist did not find it important to distinguish between a drug and toxicant), and this is an opportunity for students to reflect on the theory-laden nature of science (Lederman et al., 2002; McComas, 2002). Specifically, this stage presents an opportunity for students to reflect on how each scientist’s theoretical commitments based on his or her training and background result in different scientists using the terms differently. Student ideas are discussed as a whole class, which presents another opportunity for communication.

**○ Assessment**

By the end of the activity, students should be able to communicate the different definitions and uses of the terms. Students can be assessed by asking them to write a journal response or exit slip, or by having a whole class discussion of the following questions:

- What is a drug? Poison? Toxicant? Toxin?
- What did the sorting activity show you about how substances are classified in these four categories?
- How can some drugs be considered toxicants and vice versa?
- How has this activity changed how you view drugs, poisons, toxicants, and toxins?

**○ Conclusion**

This activity provides an illustration of how students can engage with the academic language of biology in ways that support the goals of ELA CC and NGSS. It differs from common experiences in which definitions are provided to be memorized, and instead provides opportunities for students to connect academic language with their everyday language. The rest of the curriculum unit provides additional opportunities for students to understand and apply these terms. For example, later in the unit students engage in the scientific practice of planning and carrying out investigations to test how different substances affect planarians. We encourage teachers to adapt and modify the activity and curriculum unit to best meet their instructional objectives and the needs of their students. Teachers have reported that the activity has been meaningful for their students, whether they were in an introductory or an advanced biology class. Whether the activity is used in its current form or adapted for use in other units, we hope that it illustrates possible ways to engage students in the academic language of biology.

**Online Materials**

Lesson plans, substance cards, student activity sheets, interview videos, and other curriculum materials are available online at <http://neuron.illinois.edu/>

**Table 1. Terms and corresponding descriptions.**

Term	Characteristics
drug	intentionally consumed and has the capability to alter brain or behavior
poison	results in impairments or death of an organism
toxicant	has a harmful effect on organisms when introduced to the environment
toxin	produced by an organism and is harmful to other organisms

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