# Structure–Function Lab in a Bag

***By Nora Egan Demers***

This hands-on activity stimulates students to consider the close relationship between structure and function. This inquiry-type lab can be done as a group or cooperative learning experience using simple kitchen tools. The activity provides a fun icebreaker activity for the first day of class, helps introduce students to the concept of science as a process, and demonstrates one aspect of evolution: evolution by mutation and descent with modification.

This activity is a great introduction to a semester- or quarter-long class that focuses on biological sciences, but it is also suitable for other natural sciences. It can be used in biology classes as an introduction to the important relationship between structure and function. Because of its hands-on nature, the activity is suitable for students with special needs, except those with severely impaired motor functions. This activity helps students answer the following questions:

- What is the relationship between structure and function?
- How do these properties relate and explain how objects work?
- How can ordinary kitchen tools be used to better understand the process of science as performed by a community of scientists?
- How does this concept apply to biology?
- How does evolution through mutation and descent with modification work?

## Preparation

### *Student preparation*

Students will need to bring a pencil or pen and a notebook to class.

### *Teacher preparation*

Materials (for a class of 60–90 students; students can work in pairs or groups of 3):

- 15 brown paper lunch bags labeled “A”
- 15 brown paper lunch bags labeled “B”
- variety of kitchen items

Teachers should acquire or purchase a variety of simple and complex kitchen tools (for suggestions, see the Appendix). Simpler items are placed in bags labeled “A” and the more complex items are placed in bags labeled “B.” Each item should be in its own bag. In theory, this activity would work with any set of functions that uses tools (e.g., auto mechanics, plumbing, carpentry), but as we found out when browsing antique stores for possible items, unless a person has some acquaintance with the overall field of endeavor and the tasks performed in that occupation, it is virtually impossible to guess a tool’s purpose. Kitchen instruments were chosen because even if students don’t cook, most have some familiarity with what goes on in a kitchen. If possible, find antique items so that the evolution of the products and the materials used to produce them is more apparent. For example, there are a variety of corkscrews, and handheld eggbeaters have evolved to be much more streamlined or even electric. Items from other cultures could also be included.

## Class time

The amount of class time can vary. The activity has been done as a standalone activity lasting approximately 50 minutes using the instruction provided to students, with approximately 20 minutes for follow-up discussion and questions. Alternatively, the exercise has successfully been incorporated into a 2.5-hour combination lecture–lab class during which the different components of the activity have been interspersed with the lecture at appropriate places to highlight the concepts being discussed (e.g., organization/structure, scientific process/community of learners/building on prior knowledge, evolution, and descent with modification).

## Activity

The relationship between structure and function is integral to the biological sciences. Students are asked to learn about cell structures and how they function in a variety of ways, ranging from memorization to microscope work to actual lab experiences. The importance of the structure–function relationship is constantly emphasized during the course. It is often hard to visualize, especially for cellular and molecular biology students, as the molecules and organelles may not even be visible under a microscope.

This activity provides a fun and simple macroscopic model that gives students an opportunity to develop or hone their drawing and observation skills and provides motivation and an interactive way to start off class. An ice-breaker activity helps students interact and get to know each other as a community of learners. Students explore for themselves and with each other how closely structure is related to function. They also learn, through guided inquiry and discussion, that science is a collaborative process that builds on prior knowledge. Mechanisms of evolution through mutation and descent with modification are demonstrated.

**FIGURE 1**

**Worksheet for lab exercise.**

**Structure/function correlation: A lab exercise for biology and the natural sciences**

*"If you want to know how a machine works, you must first know something about the nature and behavior of its moving parts"* (McIntosh and McDonald 1989).

Structure and function are directly correlated. An understanding of the structure of any object provides insight into understanding its function. Conversely, if the function of an object is known, it is often possible to make basic predictions about its structure. The correlation between structure and function is evident in both organisms and machines.

For this exercise, the class will be divided into groups (three students per group). Each group will be given an object in a bag labeled "A" and a second object in a bag labeled "B." Each group will answer questions 1 through 5 for each object. Each student in the group should keep a separate written record of the answers to these questions. For question 6, each student will prepare an independent answer and submit a well-formulated paragraph before the next class session.

**Questions**

1. What is the primary function of this object? If you don't recognize it, consider questions 2 and 3 below and give an educated guess. Explain the reasoning behind your guess.
2. What are the parts you can see? (List the parts without damaging the item.) Include parts such as screws, nuts, staples, etc., in your list. Make a small sketch to show the relationship of the parts (perhaps an "exploded" view).
3. What is the function of each part? (Include all parts.)
4. Could this item be different in some way: shape, size, material, other physical characteristics (e.g., color) and still perform its intended function(s)? If so, in what ways? If not, or if differences would only be cosmetic, explain why its configuration is essential to its function.
5. Could any of the parts of the object be removed without affecting its function (would it still work if it was missing a part)?
6. What is meant by the idea of structure/function correlation? Illustrate your explanation with at least one specific example other than one of the objects used in the lab. Consider other simple machines or tools you might use. Write a minimum of one paragraph.

## Procedure

Provide each student or group of students with the labeled bags containing the kitchen tools and the worksheet (Figure 1). Explain what the assignment entails and circulate around the room as the students complete the assignment.

## Class discussion and debriefing

When each student or group of students has sufficiently identified and described an item, ask the entire class to show what their item is and identify its function. Depending on time constraints, this sharing can be done in groups, individually, or with the instructor selecting particular items to highlight. Usually what happens is that the "A" items are recognized and known by most students, whereas the "B" items are not. When this happens, ask the class or groups if they know what the unknown item is. Often some students know. When they shout it out, ask them how they knew. The students will probably answer that they have used it, they saw someone use it, or someone else told them. These are examples of prior knowledge and they demonstrate that scientists are observant, build on prior knowledge, and seldom work in isolation.

Next, ask students to find other students in the class who have items similar to their item and have them group together and talk with each other about the similarity and differences among their objects. The antique versions of kitchen implements can set the stage for such a discussion. This should naturally lead into a discussion about how kitchen items have evolved as life on Earth has evolved. Some items have gained improved functionality with diversity, and some have simply gained diversity. It is important to acknowledge that the "evolution by descent with modification" seen in these tools does represent intelligent design, unlike evolution in biology.

Including implements with different levels of complexity enhances the possibility for students to discuss evolution; however, be cognizant that students may end up with incorrect ideas about evolution (e.g., that evolution is a directed process; that it requires some intelligent agent to proceed, as making cooking implements does; that advanced structures are necessarily more complex than primitive structures; and that evolution without intelligent design is impossible because of the issue of irreducible complexity). Thus, steps should be taken (or at least questions raised in the exercise) to ensure that students are not misinformed.

## Method of evaluation

Students could provide the completed worksheet in their portfolio or as a homework assignment to be turned in for grading. The only written assignment I grade is the single paragraph answer to question number 6. This can be as simple as verifying that the student completed the assignment, wrote a complete paragraph, and/or provided an explanation of a simple object other than a kitchen tool that was used in the class. Often, I remark that a pencil or a comb is an excellent simple object to explain, or that perhaps a car is too complex to be explained in a single paragraph.

## Extension/reinforcement

This activity can easily be expanded and reinforced as other concepts are addressed during the semester. Continually refer to this simple example as you explain the structure and function of the polarity of water, the hydrogen bonding that leads to alpha-helices, the cell membrane, and other important concepts in the natural sciences.

It is useful for the course instructor to continuously refer to the activity and the structure–function relationship when providing explicitly biological dimensions. For example, during a session on feeding strategies, when students look at different mouthparts of fishes, the instructor can refer to the activity when noting the nuances of the diversity of functions that go along with the range of structures that have evolved to meet the different prey available in the various niches.

## Acknowledgments

*This lab was developed by Linda Kahan at the Evergreen State College in Olympia, Washington, and adapted with the addition of scientific process and evolution components by Nora Egan Demers.*

## Reference

McIntosh, J.R., and K.L. McDonald. 1989. The mitotic spindle. *Scientific American* 261 (4): 48–56.

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## APPENDIX

**Examples of kitchen items.**

Especially valuable for physiology-focused students are items with moving parts such as ice cream scoop with scraper that expels ice cream, nutcrackers, apple peeler (the old fashioned kind that clamps to a counter), rotary egg beater, kitchen scissors, pot lifter (the kind that looks like channel lock pliers), camping tool, pepper/spice grinder (look for one that is made of Lucite, e.g., combined salt shaker/pepper grinder that could be operated by squeezing with one hand), mechanical coffee grinder, wire whisk, salad tongs with two sides joined like scissors, French press coffee press, hard-boiled egg slicer, chip bag clip, flour sifter, and canning jar lifter.

Additional items that may be suitable include spatula of various types and sizes (spatula for baby jars with specialized tab for getting under the jar lid and hook for hanging), strainer, strainer customized to hang from sink faucet, potato peelers of various types, cheese graters (simple or complex), corkscrews, (hand) juicers, garlic presses (some even include olive pitters), shrimp deveiners, orange peelers, apple corers, salad spinners, bakers tools, cake decorating items, egg separators, meat tenderizers, grinders, and steamer and heat diffuser (both made of the same material with different functions but both exposed to extreme heat).