INVESTIGATION

Time	90 minutes
Teacher Preparation	
Student Difficulty	
Lab Binder	Diversity, pp. 1–3

TEACHER TESTED

Purpose Construct and use a dichotomous key to identify limpet shells.

Overview Students will identify characteristics of limpet shells that can be used to categorize the shells. Students will then

- construct a dichotomous key using the characteristics of limpet shells
- use the dichotomous keys of other students to identify the limpet shells

LAB PREPARATION

Become familiar with important limpet shell characteristics that students could include in their dichotomous keys, including:

- presence or absence of a hole in the top of the shell
- size, shape, and color of the shell (inside and outside)
- pattern of coloration
- margin variation (smooth or crenulated)
- presence or absence of ribs or ridges on the outside of the shell

LAB MANAGEMENT

- If students are having difficulty deciding what characteristics of limpet shells to use for their dichotomous keys, you may want to describe the characteristics of one limpet shell together as a class.
- Students can find additional information on the nine limpet species on the Internet or in field guides to shells. Field guides to cor reefs, seashores, or to a particular geographic area, such as the Carib- bean, may also be useful.

MATERIAL
set of or photographs of limpet shells

PROCESS SKILLS
- Observing
- Identifying
- Classifying

Creating a Dichotomous Key for Limpet Shells

Limpets are marine invertebrates found along rocky shorelines around the world. The flattened shape of a limpet's shell allows it to withstand the impact of waves, and its muscular foot allows it to cling tightly to rocks. Although biologists today classify limpets by using traits of the entire organism, for this activity you will construct a dichotomous key based on shell characteristics.

Dichotomous keys are used to identify objects or organisms that have already been described by another scientist. As its name implies (*di-* means "two"), a dichotomous key is made up of paired statements. Each pair of statements divides the objects to be classified into two categories. This means that each object must fit into one category or the other, but not both. At the right is a simple example of a dichotomous key that identifies five common beans. As you proceed from step to step, the classification is narrowed down until all five beans are identified.

SAMPLE DICHOTOMOUS KEY FOR BEANS

1.a.	If the bean is round ..... it is a garbanzo bean
1.b.	If the bean is oblong ..... go to step 2
2.a.	If the bean is white ..... it is a white northern bean
2.b.	If the bean is dark-colored ..... go to step 3
3.a.	If the bean is a solid color ..... go to step 4
3.b.	If the bean is speckled ..... it is a pinto bean
4.a.	If the bean is black ..... it is a black bean
4.b.	If the bean is reddish-brown .... it is a kidney bean

PROBLEM What characteristics can you use to make a dichotomous key for limpet shells?

PROCEDURE

1. Identify some characteristics of each limpet shell. Characteristics may include margin (edge) variation, shape, color, and features on the shell.
2. Construct a dichotomous key, using the above sample for beans as a guide. Start with a general characteristic that separates your limpets into two groups. (**Example:** Keyhole limpets have a hole at the highest point of their shell; true limpets do not.)
3. Continue making paired statements that become more detailed.
   - Each pair of statements must contain only two choices, and these choices must refer to the same characteristic. (**Example:** Do not compare size and color in the same pair of statements.) Every limpet that has not yet been identified must fit one of the two choices.
   - Do not use vague terms such as *big* and *little*. Be as specific as possible.
   - Each statement must either identify a limpet or lead to another step in the key.
4. Trade dichotomous keys with another student or group in your class. Check to make sure you can identify each limpet using your classmates' key.


Cellana testudinaria
Common turtle limpet


Collisella striata
Striate limpet


Patelloida saccharina
Sugar limpet


Fissurella nodosa
Knobbed keyhole limpet


Fissurella maxima
Giant keyhole limpet


Cellana radiata
Rayed limpet


Nacella deaurata
Patagonian copper limpet


Fissurella barbadensis
Barbados keyhole limpet


Megathura crenulata
Great keyhole limpet

ANALYZE AND CONCLUDE

1. **Summarize** How did you organize the limpet shells?
2. **Analyze** What different categories did other groups use to organize the shells?
3. **Identify Problems** What problems arose as you constructed your key?
4. **Infer** If you were given the actual shells, what additional characteristics could you have used to make your key?
5. **Apply** Two outcomes are said to be mutually exclusive if they cannot both occur at the same time. For example, heads and tails are mutually exclusive outcomes of flipping a coin. Why is it important that the paired statements in a dichotomous key describe mutually exclusive characteristics?

INVESTIGATION

Inclusion Tell students that one of the world's foremost experts on mollusks, **Dr. Geerat J. Vermeij** of the University of California, Davis, is visually impaired. He identifies and classifies mollusk shells exclusively by touch. If, however, the shells are too worn or small, non-expert students who are visually impaired may have difficulty identifying them. These students can be given larger types of shells or other objects that can be categorized by touch.

POST-LAB DISCUSSION

Have students discuss the various ways in which they categorized the limpet shells. **Ask**

- What characteristic seemed like the best option for the first paired statements in your key? presence or absence of keyhole
- If you wanted to select out a limpet right away, in the first paired statements, what characteristic could you focus on? star-shaped shell, because only one species has this distinct feature

Determine whose key had the least number of paired statements or steps, and have that student explain his or her strategy.

This activity can be related to the use of marine mollusk shells as index fossils. Because the shapes and textures of shells are often very well preserved, as in the Burgess Shale, it is relatively easy to identify the species and use them to determine the relative age of other fossils in the same or nearby strata.