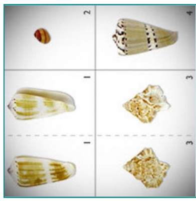


Sorting Seashells

hhmi | BioInteractive

Click & Learn
Educator Materials

OVERVIEW

This Click & Learn allows students to compare the morphological characteristics of “seashells” (marine mollusks) and construct an evolutionary tree. Students examine photos of 20 different shells. Clicking on each photo opens a short description and 3D view where the shell can be rotated and magnified. By deciding which shells are more similar to one another, students gradually build a phylogenetic tree of mollusk species.

In **Part 1** of the accompanying worksheet, students engage in a hands-on card activity in which they make observations and sort the mollusks’ shells based on shape, structure, and other features. In **Part 2**, students work through the Click & Learn to construct the evolutionary tree.

You can complement this Click & Learn with the activity “Biodiversity and Evolutionary Trees,” in which students compare DNA sequences from the same mollusks. Consider having students build the tree in the Click & Learn first, then use the “Biodiversity and Evolutionary Trees” activity to explore whether that tree is supported by genetic data.

Additional information related to pedagogy and implementation can be found on this resource’s webpage, including suggested audience, estimated time, and curriculum connections.

KEY CONCEPTS

- Phylogeny is based on evolutionary relationships.
- A phylogenetic tree can be built by repeatedly identifying both the most dissimilar members and the most similar members in a group of organisms.
- Hard remains such as fossils, bones, and shells may not give sufficient clues to group organisms correctly.
- Superficial similarity does not always indicate a close evolutionary relationship.
- Even experts do not always agree on the subtleties of some evolutionary relationships.

STUDENT LEARNING TARGETS

- Group organisms based on shared characteristics, then use details about organisms’ morphologies to propose how they are evolutionarily related.
- Interpret simple phylogenetic trees.
- Use phylogenetic trees to compare hypotheses about evolutionary relationships among groups of organisms.
- Explain how morphological information can be used to study evolutionary relationships.

PRIOR KNOWLEDGE

Students should have a basic understanding of:

- the classification of species or organisms
- interpreting phylogenetic trees

MATERIALS

- copies of the “Student Handout”
- copies of “Shell Cards” (several printing options are provided on the resource’s webpage)

TEACHING TIPS

- Encourage students to work in groups of two or three, especially for the card activity in Part 1.
- For students who need extra language support, including English Language Learners:
  - Create a "word wall" to help students learn and use key vocabulary from the activity, including terms that may be unfamiliar in a scientific context. These terms could include mollusk, morphological, evolutionary, relationship, ancestor, and venom.
  - Encourage students to work together, discuss their answers, and ask additional questions as they work. Talking through ideas helps students develop stronger language skills.

PROCEDURE

Before the Activity

1. If you are using printed copies of the "Shell Cards," print and cut out the cards in advance. Card files are available on this resource's webpage in both color and black-and-white, with single-sided or double-sided printing options.
   a. In the single-sided files, each shell has a large card with two images (showing the front and back of the shell). Cut out each large card, fold it in half, and then tape it together to make a double-sided card.
2. At the start of the activity, activate students' prior knowledge and build engagement. For example:
   a. Tell students that the shells in the activity are from marine mollusks of the Philippines. Show where the Philippines are on a map of the world if needed.
   b. Point out that the Indo–West Pacific region, including the Philippines, is rich in marine biodiversity. Show students "Surrounded by the Ocean," a 12-minute mini-documentary of Philippines biodiversity, or the 2-minute video clip "Philippines Biodiversity."
   c. Introduce students to some interesting mollusks, such as the cone snails featured in the activity. Cone snails are venomous and carnivorous; some hunt fish, others hunt snails or worms. You can highlight the feeding behavior of cone snails using "Cone Snail Strikes a Fish," a 2-minute video clip showing a fish-hunting species, or "Cone Snails: Versatile Hunters," a 13-minute video on cone snails.

Part 1

3. Distribute the "Shell Cards" to each student or small group (2–3 students).
4. Allow students to sort the cards in a way that makes sense to them, following the instructions in Part 1 of the "Student Worksheet."
   a. If helpful, students can also use the gallery on the first page of the *Sorting Seashells* Click & Learn, which allows users to rotate the shells for closer examination.
5. Ask students to explain why they sorted the shells the way they did. Discuss problems of sorting according to size, color, or texture and why those characteristics may not necessarily indicate evolutionary relationships.

Part 2

6. Have students work through the entire *Sorting Seashells* Click & Learn and answer the accompanying questions in Part 2 of the "Student Worksheet."
7. If desired, you can make this part more hands-on by having students draw the phylogenetic tree on a piece of paper, whiteboard, or blackboard. They can then place the shell cards on the appropriate branches. The diagram below shows the final phylogenetic tree in the Click & Learn.

1. *Conus magus* The Magician's Cone
2. *Neritina communis** Zigzag Nerite
3. *Bursa nobilis* The Noble Frog Shell
4. *Conus capitaneus* The Captain's Cone
5. *Cypraea annulus** The Ringed Cowrie
6. *Conus marmoreus* The Marble Cone
7. *Neritina communis** Zigzag Nerite
8. *Distorsio anus* The Distorted Anus
9. *Conus omaria* Omaria Cone
10. *Cypraea isabella* Queen Isabella's Cowrie
11. *Pecten pallium* The Ducal Mantle
12. *Cypraea tigris* The Tiger Cowrie
13. *Conus ebraeus* The Hebrew Cone
14. *Cypraea annulus** The Ringed Cowrie
15. *Conus chaldeus* The Astrologer's cone
16. *Neritina communis** Zigzag Nerite
17. *Imbricaria conularis* The Cone-shaped Miter
18. *Conus circumcisus* Circumcision Cone
19. *Cypraea moneta* The Money Cowrie
20. *Turris babylonia* Tower of Babel

*Out of all the shells marked with an asterisk (*), only 2 and 5 are shown in the diagram. This is because 2, 7, and 16 are all *Neritina communis*, and 5 and 14 are both *Cypraea annulus*.

ANSWER KEY

PART 1: Sorting Shell Cards

1. Sort the shells into **3–10 groups** in a way that makes sense to you. Describe how you sorted the shells below. You can list the numbers of the shells in each group or draw a quick diagram.
   Answers will vary.
2. Describe the characteristics and reasoning you used to sort the shells.
   Answers will vary, but students' sorting will most likely be based on size, color, and/or shape.
3. What other information about the mollusks that had each shell would have been helpful to know when sorting the shells?
   Students might mention behavioral characteristics (e.g., what the mollusk eats or where it lives), developmental characteristics (e.g., how the mollusk grows and develops), and/or DNA sequences.
4. Select the definition that most closely describes what you did.
   Taxonomy: Organizing organisms into groups according to a set of rules, based on similarities or differences in their characteristics.

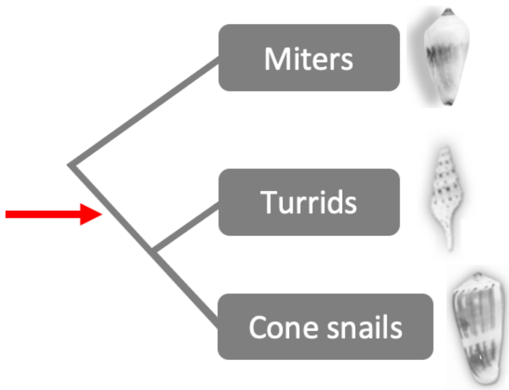
PART 2: Building a Phylogenetic Tree

5. Which type of mollusk was chosen as the first outgroup for the phylogenetic tree? Explain at least **two** ways in which that type of mollusk significantly differs from the others. (*Hint*: Watch the video clip called "Dr. Olivera discusses major molluscan groups.")
   The scallop was chosen for the first outgroup. It is a type of bivalve, a mollusk that has two shells connected by a soft-tissue hinge. All the other mollusks are snails/gastropods, which have a single spiral shell. Other differences between bivalves and gastropods include the fact that bivalves typically don't move much, whereas gastropods can be very mobile. In addition, most bivalves are filter feeders, whereas gastropods can be herbivores, detritivores, or predators.

6. Explain what the branches on a phylogenetic tree represent.
   The branches represent evolutionary relationships.

7. Describe one example from the Click & Learn in which shell texture, color, or shape was not a reliable indicator of evolutionary relationships. What was a more reliable indicator in that case?
   Answers will vary. One example is from the second outgroup, nerites. What distinguishes the nerites from the other groups of gastropods is soft tissue, which is not a trait that can be determined from the shells.

8. Some of these snails produce venom that could be used to make new medicines. As mentioned in the Click & Learn, turrids and cone snails produce venom, but miters do not.
   a. Using the tree below, label or describe where the venom system most likely evolved.
      As indicated by the arrow on the tree below, the evolution of a venom system probably happened in the most recent common ancestor of turrids and cone snails.



   b. Suggest at least one other scenario for where the venom system evolved. Why is this scenario less likely than the one you chose above?
      One possibility is that the venom system evolved in the common ancestor of miters, turrids, and cone snails, and was later lost in miters. Another possibility is that the venom system evolved independently in turrids and cone snails. These scenarios are less likely than the one mentioned above because they are more complicated and require more evolutionary changes. (You can use this question to introduce the concept of parsimony in phylogenetic analyses.)

9. How does the final phylogenetic tree in the Click & Learn compare to the groups you made in Question 1?
   Answers will vary, but students should remark on the hypothetical evolutionary relationships diagrammed in the phylogenetic tree.

10. The phylogenetic tree in the Click & Learn was built based on morphological characteristics. Which other characteristics of organisms could be used to build a phylogenetic tree?
    Answers will vary. Students may mention DNA sequences, which are key to modern taxonomy.

CREDITS

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