Khaled bin Sultan Living Oceans Foundation

STANDARDS

- **CCSS**: RST.9-10.1, 2, 3, 4, 5, 7, 8, 9, 10; RST.11-12.1, 2, 3, 4, 7, 8, 9, 10; W.9-10.2, 4, 7, 8, 9; W.11-12.2, 4, 7, 8, 9; SL.9-10.4, 6; SL.11-12.4, 6
- **NGSS**: HS-LS4-1
- **OLP**: 4.B.1, 4.B.2, 5.C.22

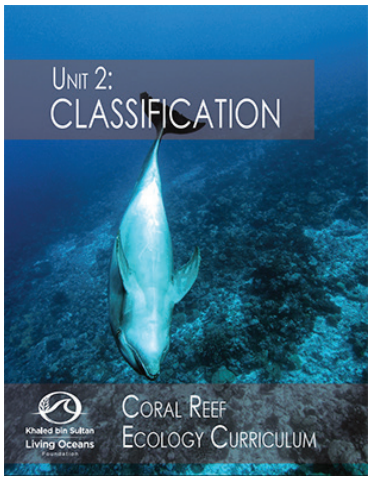
ONLINE CONTENTS

- Classification Quiz
- *What Clade R U?* Interactive (at bottom of *How To Build A Cladogram* section) Use the interactive program to learn and explore more about the anatomy of a stony coral polyp.
- *What Are Corals?* Video Classification helps scientists tell species apart. This educational video explains modern biological classification categories from the most general (domain) to the most specific (species).

CLASSIFICATION

This lesson is part of the *Classification* unit, which explains how to organize the millions of organisms on Earth. Below is a summary of what is included in the entire unit.

UNIT CONTENTS



A. Background Information
   - How Do We Classify Organisms?
   - Linnaean Naming System
   - Coral Classification
   - Modern Classification
   - Understanding Cladograms
   - How to Build a Cladogram

B. Lessons

Watch It! Naming Nature
- A worksheet to accompany the *Naming Nature* video

Classify This!
- A worksheet to classify an organism and identify its characteristics

Rules, Rules, Rules
- A worksheet about scientific names

"Taxing" Corals
- An activity to classify corals based on their characteristics

In Light of New Evidence
- A writing assignment on an organism that has been reclassified

The Key to ID
- An activity using a dichotomous key for sea stars

And Then There Was One
- An activity to create a dichotomous key for corals

Cladograms 1
- A lesson on creating and interpreting a cladogram

Cladograms 2
- A lesson on creating and interpreting a cladogram (with traits already included)

Read It! Troubling Taxonomy
- A worksheet to accompany the *Troubling Taxonomy* field blog

Read It! Blue, You Say?
- A worksheet to accompany the *Blue, You Say?* field blog

Lesson 4A Teacher's Notes

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Learning Objectives

- Use a dichotomous key to classify organisms.
- Classify organisms based on their physical characteristics.

Keywords

- Classification
- Dichotomous Key
- Taxonomy

Materials

- **Appendix A: Sea Star Photos**
- **Appendix B: Sea Star Dichotomous Key**
- **Watch It! Naming Nature** student worksheet
- **Lesson 4A: The Key to ID** student worksheet

Resource

- Humann, P. & DeLoach, N. (2010). *Reef Creature Identification: Tropical Pacific*. New World Publications.

Standards

- CCSS: RST.9-10.4, 5; RST.11-12.4
- NGSS: HS-LS4-1
- OLP: 4.B.1, 5.C.22

Procedure

1. Watch *Naming Nature* YouTube video (https://youtu.be/5h5nSivm1KI) and answer questions on **Watch It! Naming Nature** student worksheet.
2. Teach *Unit 2: Classification - Background Information*.
3. Before beginning the activity, you may want to print dichotomous keys and sea star photos (found in **Appendix A** and **B**) and laminate them, so that they can be used again. The sea star photos will need to be printed in color in order to correctly identify them.
4. Hand out **Lesson 4A: The Key to ID** student worksheet.
5. Teach *Additional Background Information* on **Lesson 4A: The Key to ID** student worksheet.
6. OPTIONAL: Provide an example on how to use a dichotomous key. There are two additional photos included in this lesson plan. Use these photos as an example.
7. Ask students to use the dichotomous key to classify the sea stars in the photos.
8. Instruct students to answer questions on their worksheet using the sea star dichotomous key.

Name: _____ Date: _____

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LESSON 4A The Key To ID

ADDITIONAL BACKGROUND INFORMATION:

What is a dichotomous key? A **dichotomous key** is a tool used to help identify unknown organisms based on a key. The key has a series of choices that leads the user to correctly identify organism(s). Dichotomous means to *cut into two*. Each series of statements consists of two choices. These statements describe different characteristics that the unknown organism may have. The person using the key must decide which statement best describes the unknown organism. Once the user chooses the statement, then they follow the directions, which will lead them to the next set of two statements. Again, the user chooses the best statement and again follows the directions leading them to another set of two statements. This process will continue until the user is left with the name that identifies the organism.

Why do scientists use dichotomous keys? Dichotomous keys help scientists to classify organisms into different taxonomic levels (kingdom, phylum, family, etc.) based off of their similar characteristics. You will now learn how to use a dichotomous key.

INSTRUCTIONS:

Scientists just got back from surveying a coral reef. They need help identifying these sea stars. Use the *Sea Star Dichotomous Key* to identify these unknown species. Write your answers in the table below. The number in the table corresponds to the number on the sea star photos.

Photo #	Sea Star Common and Scientific Name
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

INSTRUCTIONS: Answer the following questions.

1. Which sea stars are the most closely related?

2. Do you think that there are any other ways to create this dichotomous key? Provide one example.

3. Were there any species that were more difficult to identify than others? Explain.

4. Are there any disadvantages to using a dichotomous key?

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LESSON 4A The Key To ID

ADDITIONAL BACKGROUND INFORMATION:

What is a dichotomous key? A **dichotomous key** is a tool used to help identify unknown organisms based on a key. The key has a series of choices that leads the user to correctly identify organism(s). Dichotomous means to *cut into two*. Each series of statements consists of two choices. These statements describe different characteristics that the unknown organism may have. The person using the key must decide which statement best describes the unknown organism. Once the user chooses the statement, then they follow the directions, which will lead them to the next set of two statements. Again, the user chooses the best statement and again follows the directions leading them to another set of two statements. This process will continue until the user is left with the name that identifies the organism.

Why do scientists use dichotomous keys? Dichotomous keys help scientists to classify organisms into different taxonomic levels (kingdom, phylum, family, etc.) based off of their similar characteristics. You will now learn how to use a dichotomous key.

INSTRUCTIONS:

Scientists just got back from surveying a coral reef. They need help identifying these sea stars. Use the *Sea Star Dichotomous Key* to identify these unknown species. Write your answers in the table below. The number in the table corresponds to the number on the sea star photos.

Photo #	Sea Star Common and Scientific Name
1	**Granular sea star (*Choriaster granulatus*)**
2	**Indian sea star (*Fromia indica*)**
3	**Cushion star (*Culcita novaeguineae*)**
4	**Blue sea star (*Linckia laevigata*) – white**
5	**Watson's sea star (*Gomophia watsoni*)**
6	**Panamic sea star (*Pentaceraster cumingi*)**
7	**Crown-of-thorns sea star (*Acanthaster planci*)**
8	**Galapagos blue sea star (*Phataria unifascialis*)**
9	**Blue sea star (*Linckia laevigata*) – blue**
10	**Luzon sea star (*Echinaster luzonicus*)**
11	**Warty sea star (*Echinaster callosus*)**
12	**Cuming's sea star (*Neoferdina cumingi*)**

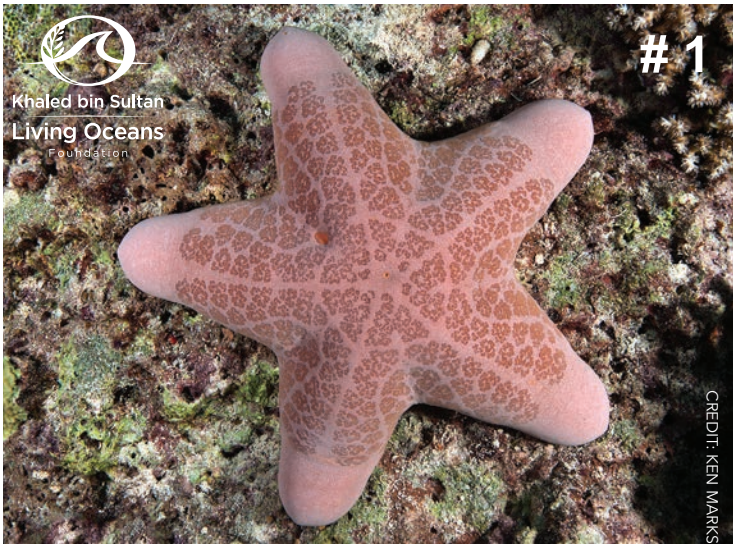
INSTRUCTIONS: Answer the following questions.

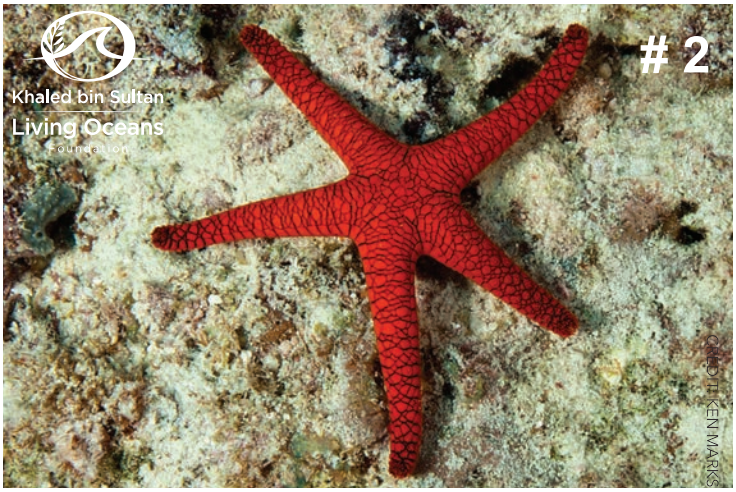
1. Which sea stars are the most closely related?
   The two blue sea stars (*Linckia laevigata*) are the most closely related. In fact, they are the same species. This might be a good time to explain to students that color is not always the best method for identifying organisms. These two sea stars are the same species, but they are able to have different color variations such as blue and white. NOTE: Students might suggest that the warty sea star (*Echinaster callosus*) and luzon sea star (*Echinaster luzonicus*) are the most closely related to each other. They are both in the same genus, *Echinaster*.

2. Do you think that there are any other ways to create this dichotomous key? Provide one example.
   Answers may vary. Yes, there are other ways to construct dichotomous keys. For example, some students may have started with the number of arms for the first set of steps. This would have completely changed the structures and steps of the dichotomous key.

3. Were there any species that were more difficult to identify than others? Explain.
   Answers may vary. Yes, the panamic sea star was difficult to identify because it was not clear if the bumps were spines or not. It was also difficult to tell if Cuming's sea star had bumps or not.

4. Are there any disadvantages to using a dichotomous key?
   Yes, there are disadvantages of using a dichotomous key. Dichotomous keys only take into account the physical characteristics of organisms. Some organisms are not easily identified by their physical characteristics and further identification is required. Second, dichotomous keys are created using a specific set of organisms. If there is a new species discovered, then the dichotomous key would have to be reconstructed to add in the new species. This can be a lot of work. Third, the scientific terminology used in dichotomous keys may not be easy to understand. Fourth, the person creating the dichotomous key may not include. a physical characteristic that is important in identifying the species. Instead, the creator uses a contrasting pair of traits that is not important to the identification of that specific organism. For example, if a scientist were to identify Watson's sea star, they would not use the blue tubercles to identify it. The color of the tubercles is actually not important. Instead, scientists would use characteristics such as tapering cylindrical arms, white undercolor with red to brown banding, and smaller tubercles than other genus members, etc.



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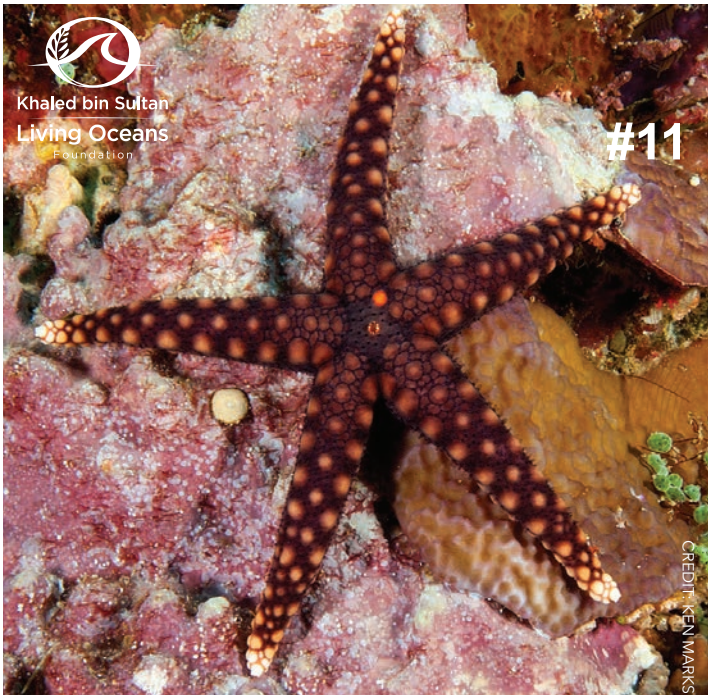
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SEA STAR DICHOTOMOUS KEY:

1a	Sea star is smooth or flat.	Go to step 2.
1b	Sea star is bumpy or spiny.	Go to step 7.
2a	Sea star has five arms.	Go to step 3.
2b	Sea star has more than five arms.	Lazon sea star (*Echinaster luzonicus*)
3a	Sea star has thin arms.	Go to step 4.
3b	Sea star has thick, short arms.	Granular sea star (*Choriaster granulatus*)
4a	Sea star has lines.	Go to step 5.
4b	Sea star does not have lines.	Go to step 6.
5a	Sea star has long blue lines down arms.	Galapagos blue sea star (*Phataria unifascialis*)
5b	Sea star has black lines in circle-like pattern.	Indian sea star (*Fromia indica*)
6a	Sea star is blue with cobblestone texture.	Blue sea star (*Linckia laevigata*) – blue
6b	Sea star is white.	Blue sea star (*Linckia laevigata*) – white
7a	Sea star has spines.	Go to step 8.
7b	Sea star does not have spines.	Go to step 9.
8a	Sea star has five arms.	Panamic sea star (*Pentaceraster cumingi*)
8b	Sea star has more than five arms.	Crown-of-thorns sea star (*Acanthaster planci*)
9a	Sea star is inflated.	Cushion star (*Culcita novaeguineae*)
9b	Sea star is not inflated.	Go to step 10.
10a	Sea star has large and pointed tubercles.	Warty sea star (*Echinaster callosus*)
10b	Sea star has small tubercles.	Go to step 11.
11a	Sea star has small blue tubercles over entire body.	Watson's sea star (*Gomophia watsoni*)
11b	Sea star does not have blue tubercles over entire body. ..	Cuming's sea star (*Neoferdina cumingi*)