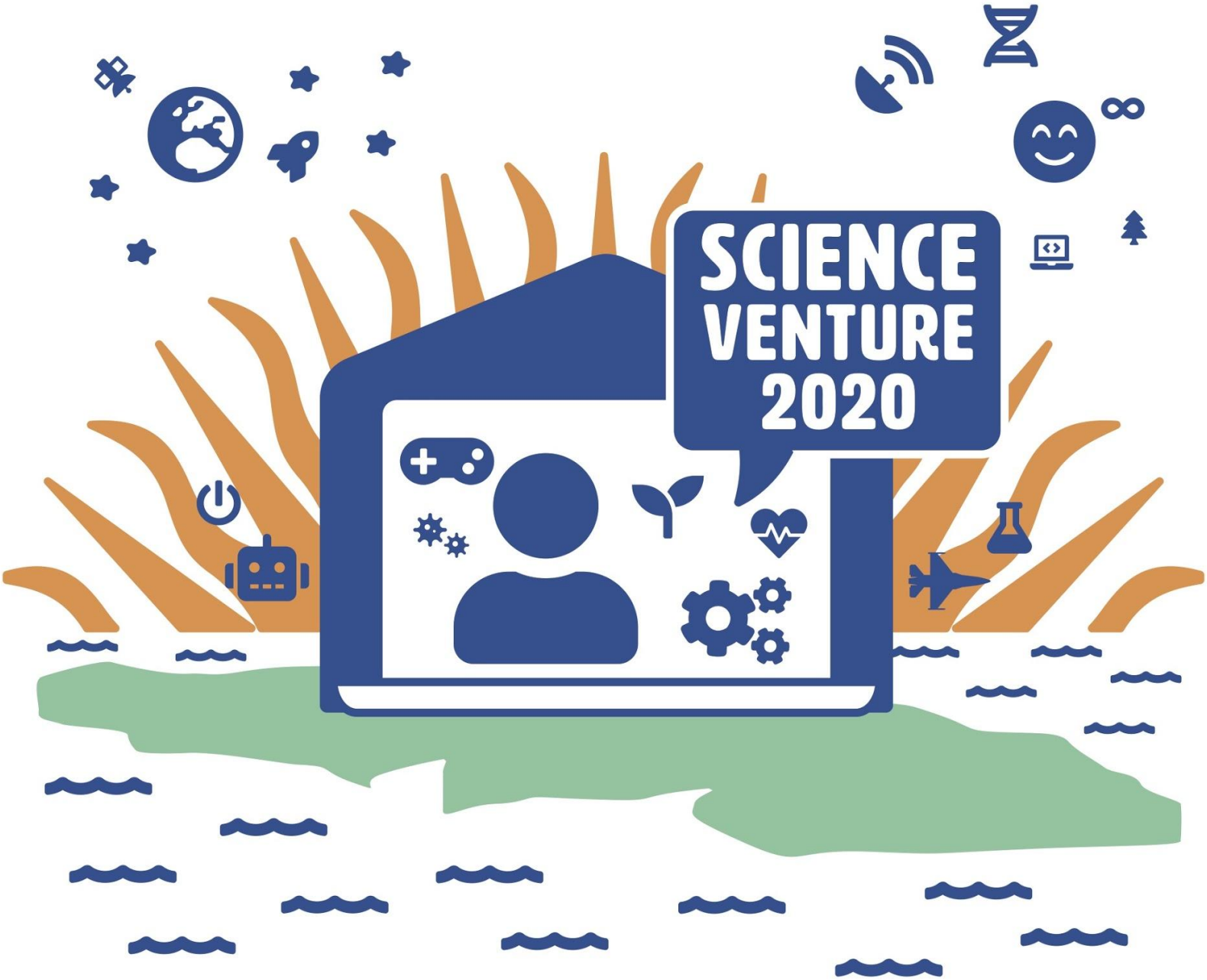


Oceanography

Dichotomous Key Creation

Youth will explore the diversity of animal observations with Inaturalist and use this to create keys that will help identify organisms to different groups. Youth will learn valuable skills related to observation and taxonomic organization that are an important tool used by scientists in a range of fields studying the natural world.

Materials

- Internet access
- Pencil
- Notebook

Safety Considerations

- Ensure that participants have appropriate supervision when using the internet.

Key Words

Dichotomous: Greek origin and meaning to split into 2 parts or to have 2 branching points

Dichotomous Key: A series of steps with 2 options that can be used to identify something unknown. (In Biology this is often used to identify species)

Morphology: A physical characteristic of an animal

Trait: A distinguishing quality or characteristic

Homologous trait: A shared physical characteristic that indicates a shared ancestry between organisms. (example: Forelimb bones in all mammals)

Analogous trait: A physical characteristic that appears similar and may serve a similar function for two different species but that has evolved separately and does not

Taxonomy: The science of naming, classifying, and organizing organisms based on shared characteristics

Evolution: The change in characteristics of biological populations over time via inheritance of different traits.

Dichotomous Key Creation

Background

Animals and other organisms such as plants, fungi, protists, bacteria and archaea have evolved over hundreds of millions of years (or billions in the case of single celled organisms). Throughout this time animals have diversified into anywhere from 1-30 million different species depending on how we estimate. Scientists have yet to discover all species in the world and considering evolution is an ongoing process and most of these organisms are very small it is unlikely we will ever discover all of them. That being said scientists continue to discover new species every day.

With so many different species it can be hard to organize and keep track of all of them. That is where taxonomy comes in, scientists can use knowledge of the **morphological** or other **physical characteristics** of organisms to group animals by how related they are. Generally groups of organisms that are more closely related will share more characteristics than those that are more distantly related. When we group related animals they are then called a **taxon**. Taxons can be very specific such as grouping animals to species or fairly broad, such as kingdom or phylum (as we will explore later in the activity).

These groupings are helpful because as scientists find new species they can compare them to known groupings to see if they truly are in fact a new species and if it is new, to see what it's closest relatives are. The main way scientists determine what group and observed organism belongs to is through a **dichotomous key**! This will be a set of steps that divide a broad group of organisms into 2 distinct groups repeatedly based on observable characteristics, gradually narrowing down until you find what group that organism belongs to.

Dichotomous Key Creation

Making a Key

When making a dichotomous key we aim to split animals or other organisms into different groups but continually splitting into 2 distinct groups. We do this by using morphological features that are different between 2 or more different organisms. This can be demonstrated using pokemon below.

We start at the top of our diagram with all the pokemon, I split them originally based on colour but this feature will be different depending on the group you are looking at. Each branch point needs to have a question or method of dividing the group that heads down exactly 2 possible paths. At each point as we move further down the branch points we continue dividing the group until dead ends are reached as there is only one of the organisms that can be reached by following the series of questions.

Dichotomous Key Creation

Making a Key Continued

Let's try using the dichotomous key to organize one of these Pokemon by starting at the top of the example key on the next page . If I start with dewgong my only steps could be:

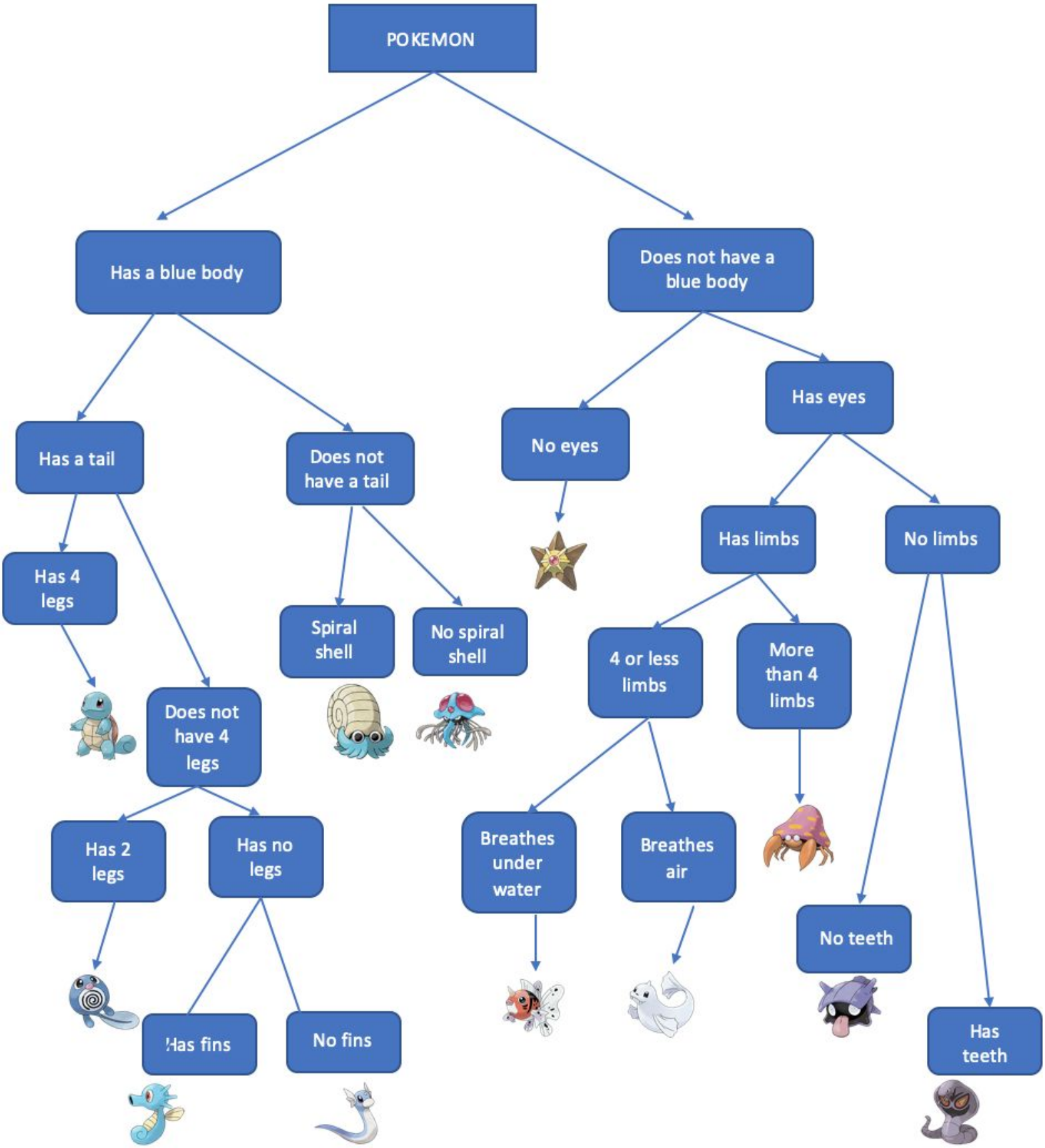
- Body is not blue so I head right
- Has eyes, so I head left
- Has limbs, so left again
- Has 4 or less limbs, so left again
- Finally, Dewgong breathes air so I head right.

If I added another animal, this time from the real world like a Beluga whale.

I would follow the same steps and conclude that my beluga might be closely related to the Dewgong. This is not a perfect analogy as pokemon are fictional characters and the beluga is real but it hopefully illustrates how a dichotomous key might be used.

Dichotomous Key Creation

Key example:



Dichotomous Key Creation

Challenge: Create your own key.

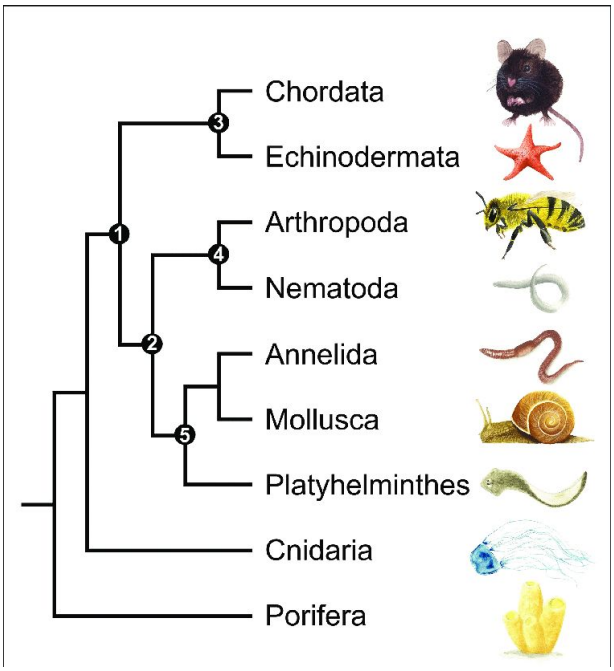
Your challenge is to design your own key based on some real life animal groupings. Scientists are constantly looking at which characteristics are most important for dividing organisms so don't worry too much about what features you use at first, try some things out and see what works! Look through the links provided on each of the phylum of animal species. These are different groups that scientists put organisms in based on their morphological features and how closely related different species are. Species that appear similar and share homologous traits will be grouped in one phylum. Some groups are more similar than others, with most of the species in that group looking similar to each other and very different from other phyla but other groups such as chordata (where humans fit) may have a very wide range of different species. You may also notice analogous traits, things that appear in multiple groups of distantly related animals. Analogous traits are not as useful in making a key so try to focus on features that are unique to each group by browsing the images people have taken or reading some of the information about the group in the "about" heading.

Procedure:

1. Browse through the links and take in the amazing diversity of animals that exist and try to find unique characteristics for each group
    a. Some examples:
        - Body shape
        - Size (overall or of certain features)
        - Eyes (y/n or type of eyes)
        - Mouth type
        - Vertebrate or Invertebrate (backbone/no backbone)
        - Symmetry: None, Radial, or Bilateral
        - Breathes Oxygen from Water or Air
        - Outer body covering: scales, fur, shell, feathers, etc
        - Any other examples you can think of (get creative!)

Dichotomous Key Creation

2. Draw a branching diagram similar to the image below and assign a question to be answered at each branching point that would help you to move through the diagram to identify an unknown species.



a. Optional: Look through the Pokemon above or here and assign one to each phylum based on its appearance.

b. Option 2: Find at least 1 marine species that belongs to each phylum by browsing the observations (Hint: if you look on the map search of INaturalist you can look at ocean or coastal locations)

3. Once you have drawn your branching key with your questions at each branch point try testing out your key. Pick a random animal in one of the phyla by browsing Inaturalist (or another website) and go through your questions, does your key get you to the correct answer? (If not you may need to make some changes)

4. Once you are happy with your key you can test it on some friends or family members! Show them an observation of an animal on Inaturalist or elsewhere and see if they can use your key to figure out what it is!

Phylum	Characteristics	Pokemon (optional)
Porifera (sponges)		
Cnidaria (Jellyfish/anemone)		
Ctenophora (Comb jellies)		
Platyhelminthes (Flatworms)		
Nematoda (Roundworms)		
Annelida (Segmented worms)		
Mollusca (clams, oysters, snails, octopus)		
Arthropoda (Crustaceans, Insects, Spiders)		
Echinodermata (Star fish, Urchins, Sand dollars)		
Chordata (Mammals, birds, reptiles, amphibians, Fish)		

Dichotomous Key Creation

Extension:

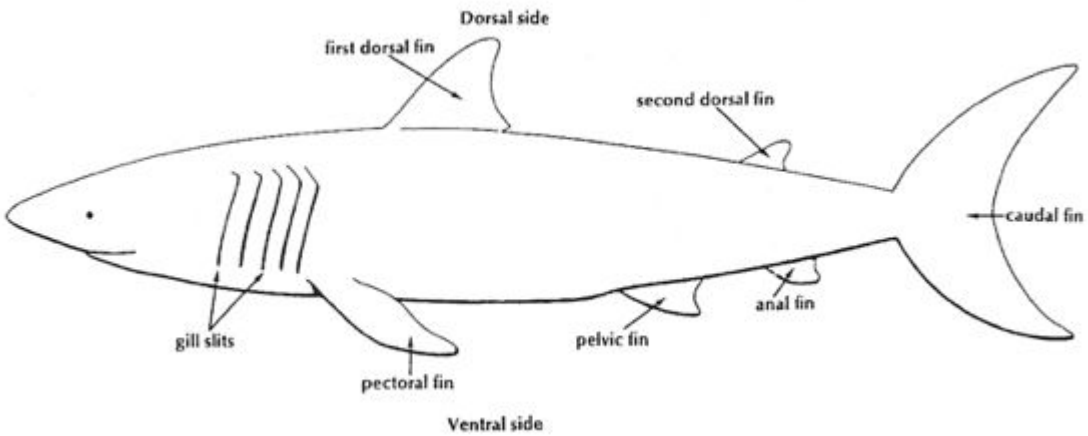
If there is a specific group of animals that interests you, you can look more closely at that group. For example sharks. Sharks are part of a group of animals called Chondrichthyes or (cartilaginous fish: referring to their soft bones). You can explore the taxonomy section if you prefer to look more closely at one group of animals and try to explore different levels of organization of animals.

We will explore an example looking at shark families but you can look at other marine animal groups such crustaceans, snails (gastropoda), or marine mammals like pinnipeds or cetaceans.

Procedure:

1. Review the general shark anatomy diagram and note the names of different anatomical structures
2. Go through the images of the different shark families and see if you can identify them using the professionally created key. (answers are provided but try not to look until after you have used the key). Representing the key in text saves space and is easier if you have lots of animal groups but can be a little trickier to use than our drawn diagrams from above, don't get discouraged if it seems hard at first!

Figure 1 – Anatomy of a Shark



Dichotomous Key Creation

Dichotomous Key to Shark Families

1. A. Body kite-like in shape (if viewed from the top) .....Go to statement 12
   B. Body not kite-like in shape (if viewed from the top) .....Go to statement 2

2. A. Pelvic fin absent and nose saw-like ..... Family Pristiophoridae
   B. Pelvic fin present ..... Go to statement 3

3. A. Six gill slits present ..... Family Hexanchidae
   B. Five gill slits present ..... Go to statement 4

4. A. Only one dorsal fin ..... Family Scyliorhinidae
   B. Two dorsal fins ..... Go to statement 5

5. A. Mouth at front of snout..... Family Rhinocodontidae
   B. Mouth on underside of head ..... Go to statement 6

6. A. Head expanded on side with eyes at end of expansion ..... Family Sphymidae
   B. Head not expanded ..... Go to statement 7

7. A. Top half of caudal fin about the same size as bottom half ..... Family Isuridae
   B. Top half of caudal fin different in size than bottom half ..... Go to statement 8

8. A. First dorsal fin very long, almost ½ total length of the body..... Family Pseudotriakidae
   B. First dorsal fin regular length ..... Go to statement 9

9. A. Caudal fin very long, almost as long as entire body ..... Family Alopiidae
   B. Caudal fin regular length ..... Go to statement 10

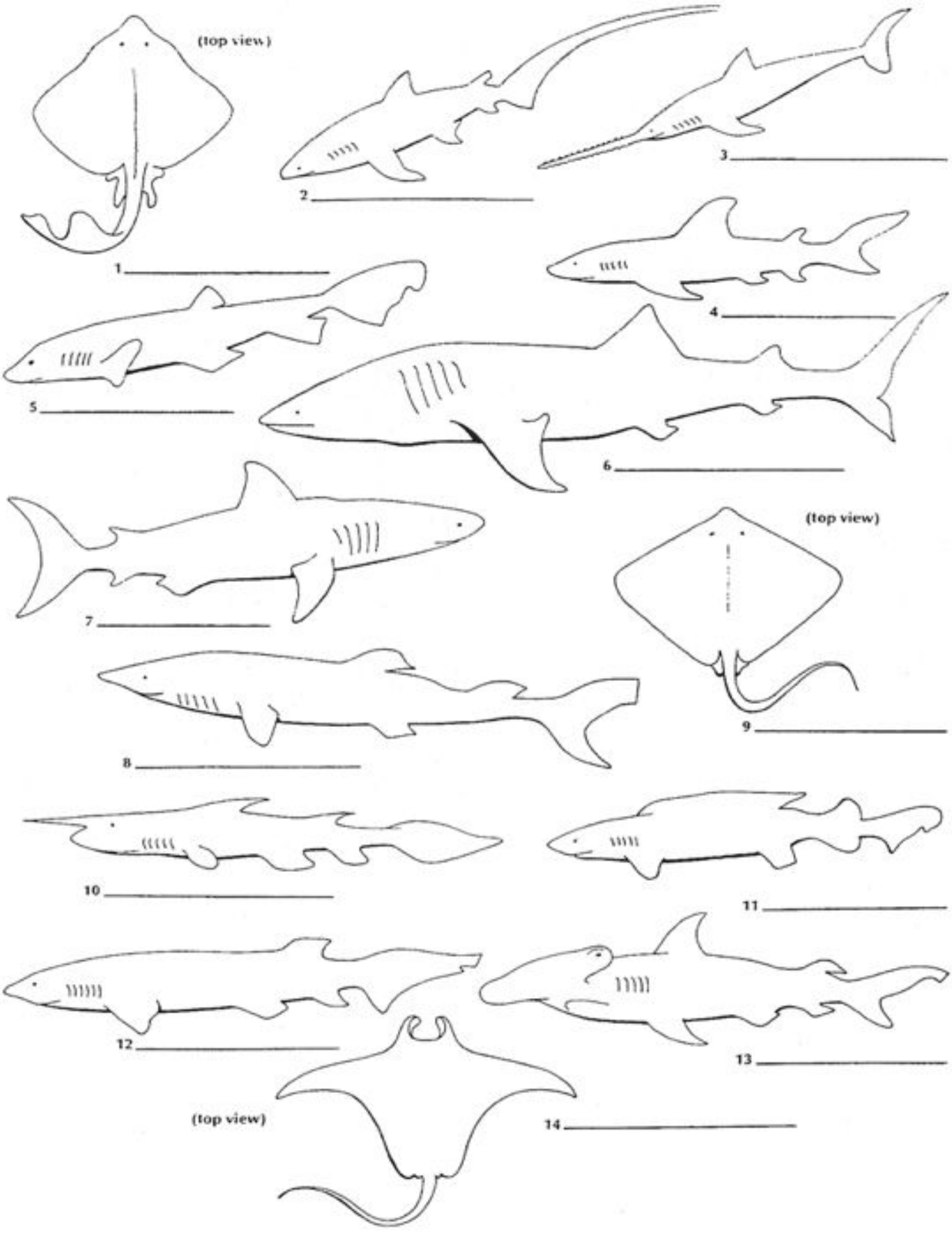
10. A. A long needlelike point on end of nose ..... Family Scapanorhynchidae
    B. Nose without long point ..... Go to statement 11

11. A. Anal fin absent ..... Family Squalidae
    B. Anal fin present ..... Family Carcharhinidae

12. A. Small dorsal fin present near tip of tail ..... Family Rajidae
    B. No dorsal fin present near tip of tail ..... Go to statement 13

13. A. Front of animal with two horn-like appendages ..... Family Mobulidae
    B. No horn-like appendages..... Family Dasyatidae

Dichotomous Key Creation



Dichotomous Key Creation

Additional Resources

Looking to continue your explorations of ocean dwelling species and how scientists categorize them? Check out these links and dive into more oceanography.

- https://www.centralcoastbiodiversity.org/
  - Curated guide to local animals, plants, and fungi
- https://www.inaturalist.org/
  - Vast resource of observations
- https://www.khanacademy.org/science/high-school-biology/hs-evolution/hs-phylogeny/v/taxonomy-and-the-tree-of-life
  - A more detailed look into taxonomy
- https://docs.google.com/presentation/d/1whiOakOB1DTYb8reqh2xQ2kkopvGGiMv2o_wv3adOsk/edit#slide=id.p90
  - Another description of how dichotomous keys work

Shark Answer Key

COMMON NAMES
1. Skate
2. Thresher shark
3. Sawfish
4. Mako shark
5. Cat shark
6. Whale shark
7. Requiem shark
8. Dogfish
9. Sting Ray
10. Goblin shark
11. False Cat shark
12. Cow shark
13. Hammerhead shark
14. Manta Ray

FAMILY NAMES
1.Rajidae
2.Alopidae
3.Pristiophoridae
4.Carcharhinidae
5.Scyliorhinidae
6.Rhinocodonididae
7.Isuridae
8.Squalidae
9.Dasyatidae
10.Scapanohynchidae
11.Pseudotriakidae
12.Hexanchidae
13.Sphyrinidae
14.Mobulidae

#SVatHome

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Email or tag us @ScienceVenture

Have a question?

Reach us at svcamp@engr.uvic.ca