

# Cephalopods



Photo by Mary Bryan, Alaska SeaLife Center

## Teacher Guide

Recommended for Grades 5-9



Distance Learning



# Alaska Academic Standards

**Science as Inquiry and Process (grades 5-9): SA1**  
**Concepts of Life Science (grades 5-9): SC2**

## National Academic Standards

### **Science as Inquiry (grades 5-9)**

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

### **Life Science (grades 5-9)**

- Structure and function in living systems
- Reproduction and heredity
- Regulation and behavior
- Populations and ecosystems
- Diversity and adaptations of organisms
- Biological evolution
- Behavior of organisms

## Objectives

Students will be able to:

- Describe the internal and external anatomy of a squid through dissection.
- Apply the scientific method in determining the gender of a squid specimen.
- Appreciate the diversity of animals in Phylum Mollusca.
- Understand the natural history and characteristics of Class Cephalopoda.
- Explain adaptations that allow Alaskan Cephalopods to live in their harsh environments.
- List 4 members of the Class Cephalopoda



# Background Information

## Phylum: Mollusca

- 128,000 existing species
- Live in marine, freshwater, and terrestrial environments
- Characteristics
  1. 3 body regions: head, visceral mass, and foot.
  2. Muscular foot can be used for locomotion.
  3. Mantle cavity, secreted by the dorsal body wall, secretes the shell.
  4. Radula: tongue with teeth like structures used for scraping food.
- Classes
  1. Aplacophora: chaetoderms, neomenioids
  2. Polyplacophora: chitons
  3. Gastropoda: snails, limpets, abalone
  4. Bivalvia: clams, oysters, muscles
  5. Scaphopoda: tooth shells
  6. Cephalopoda: nautilus, octopus, cuttlefish, squid

## Members of Class Cephalopoda

The class Cephalopoda includes about 650 living species. There are four main types of cephalopods: nautilus, octopus, cuttlefish and squid. “Cephalopod” means “head foot,” which describes the basic body arrangement of these animals. Many cephalopods have a well-developed brain and sensory organs. Although they are closely related to clams and snails, cephalopods are typically considered the most intelligent invertebrates in the world.

## Nautilus – Order Nautiloidea

The chambered nautilus lives in the South Pacific and Indian Oceans. It is the only cephalopod with an external shell, which is made of calcium. The shell can be up to 25 cm in diameter, and is comprised of 35-40 chambers that are separated by septa. Only the last chamber is utilized for living space. A siphuncle, a cord of tissue, runs through the chambers and supplies gas to them. The gas comes from respiration and is used to control the buoyancy of the nautilus. They can have up to 90 tentacles, which extend outside the shell. They propel themselves through water using the extra chambers as floats and by jet propulsion. They feed primarily on carrion, which is detected through smelling. The nautilus is a diurnal animal. During the day they live deeper in the water and at night they come up to feed. Generally they inhabit areas from 100-400 meters deep on the slopes of fringing or barrier reefs.

## Octopus- Order Octopoda

The octopus is a cephalopod, which has completely lost its shell. Its predominant body features are its mantle and its 8 arms lined with suckers. The octopus can be as small as the blue-ringed octopus, 5 cm from arm to arm, or as large as the giant pacific octopus, 5.5 meters from arm to arm. It is primarily a bottom dweller and uses its arms to move across the sea floor. When needing to



move fast, whether to catch prey or escape a predator, an octopus will use jet propulsion by forcing water out of its siphon. To eat, the octopus captures its prey by reaching out with an arm or by pouncing on it. Once the prey (fish, crab, or shrimp) is caught, the shell or bones are crushed using its beak. Two toxins are secreted into the meal as well. One chemical paralyzes or kills the food, while the other causes the muscle to fall away from the shell or bone. The radula is used to further scrape the meat off the shell or bone and to move the food into the digestion system.

The third right arm of the male, termed the hectocotylus, does not have suckers all the way to the tip. This arm is used to transfer spermatophores, packets of sperm, from the male's mantle to the female's mantle. The eggs are internally fertilized two to five months after mating, and the female lays and tends to them. The female dies shortly after the eggs begin to hatch because it is believed she does not eat during the brooding period. Females die after reproducing once. Males may reproduce multiple times before dying.

Several defense mechanisms exist in the octopus. Chromatophores, pigment granules that allow for rapid color changes, enable octopuses to stay hidden from both prey and predators. Octopuses secrete ink from their siphons to confuse their predators when escaping. Since they have no shell, they can also squeeze into very tight spaces to hide.

#### Cuttlefish-Order Sepioidea

The cuttlefish has an internal calcareous shell, called a cuttlebone, which is secreted by the mantle. This shell is porous and contains nitrogen used for buoyancy. It is often used in birdcages for birds to sharpen their beaks. The cuttlefish can range from 2.5 to 9 cm long and has 8 arms and 2 tentacles. No hooks are found on the suckers. They have a pair of lateral fringing fins that run completely around the body. The cuttlefish moves either through jet propulsion or by fin undulation. They are primarily bottom dwellers and swim 2-3 feet off the bottom. The cuttlefish feeds on shrimp, crab and other crustaceans. They can blow water onto the substrate using their siphon to scour out prey. Once they have captured the prey, the cuttlefish uses toxins to kill it. Cuttlefish generally gather together for reproduction. While mating, they display intense and intricate color patterns using chromatophores. On one side of its body, the cuttlefish displays warning colors to fend off competitive males. On the other side of its body, the cuttlefish displays alluring colors to attract the attention of females. Male cuttlefish are known to be aggressive and will fight and bite each other.

#### Squid-Order Teuthoidea

The squid has a small fragment of a shell called a pen. It is internalized. The squid has 8 arms and 2 tentacles, which, in some species are lined with hooked suckers. They can be from 1cm to 20m in length. The largest of the squid, the giant squid, have never been observed live in their natural habitat. Squid live in the water column and use jet propulsion for locomotion. Their bodies are



streamlined to create swift and directed movement. They use a giant nerve axon to cause all of the muscles to contract at one time to have effective movement. This nerve is approximately 1mm thick and has been used to study how nerves function. When squid reproduce, they move higher in the water column and gather together. A mating frenzy then occurs. The male attempts to attract a female and attach his spermatophore to her. Fertilized eggs from multiple females are attached together on the ocean floor in large masses. Both the female and male die after breeding. Thousands of squid lie on the ocean floor dead after this event. Predators will feed on the dead squid, but for some reason leave the egg casings alone.

## **Vocabulary List**

**Beak** - mouthpart used for crushing shells

**Carrion** - dead animals

**Chromatophore** - pigment patches that allow cephalopods to change color

**Diurnal** – active during the day (antonym: nocturnal)

**Fin undulation** - moving the fins in a wave-like pattern for movement

**Giant nerve axon** - nerve with a large diameter to allow messages to be passed quickly throughout the body

**Hectocotylus** - third right arm of the male octopus used for reproduction; a groove is found down its length and the suckers do not continue to the end

**Jet propulsion** - movement based on Newton's 3<sup>rd</sup> law-every action has an equal and opposite reaction; water is forced out of the siphon to propel the animal in the opposite direction

**Radula** - tongue lined with teeth, used for digging meat out of prey (some species can use the radula like a drill to pierce tough shells)

**Septa** - parts of the shell in the nautilus that separate the different chambers

**Siphuncle** - cord of tissue that runs through all the chambers in the nautilus; used to control gas level in each chamber

**Spermatophore** - packet of sperm that is transferred from the male to the female

**Substrate** - the bottom surface where an animal lives, e.g. sand, gravel, rock, woody debris, etc.



# Pre Session Activity Ideas

## Shell Classification

To introduce your students to the phylum Mollusca, bring in a box of shells. Have them identify the shells are from univalves (one shell, such as snails) or bivalves (two shells, such as a clam).

## Before & After Quiz

Answer the following questions about cephalopods as best you can, then after the lesson try the questions again and see how much you learned!

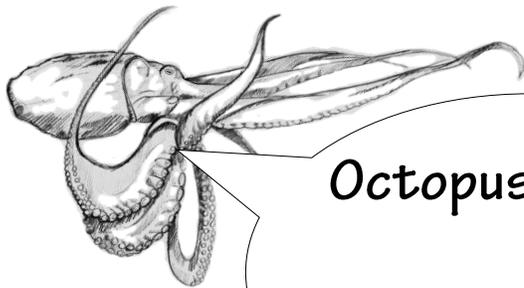
Question	Answer before lesson	Answer after lesson
1. What does the word "cephalopod" mean?		
2. What are the 4 main types of cephalopods?		
3. Which two types of cephalopods are found in Alaska?		
4. What animal has the largest eyes in the animal kingdom?		
5. How many arms does a squid have?		
6. How do squid protect themselves?		
7. How do squid move through the water?		
8. What part of the squid helps to give it shape and support?		
9. How can one tell if they have a male or female squid?		
10. How many hearts do squid have?		
<b>Scores</b>	<b>_____ out of 10</b>	<b>_____ out of 10</b>

# Session Activity: Worksheets

(Usually included in the session packet)

		Defining characteristics
<b>KINGDOM:</b>		Multi-cellular, mobile (at some point in life cycle), can't produce their own food, no rigid cell walls
<b>PHYLUM:</b>		Soft-bodied, bilateral symmetry, muscular foot, mantle, siphon  (Most have shells, radula)
<b>CLASS:</b>	<b>Cephalopods!</b>	

Record your notes about the four main types of cephalopods:

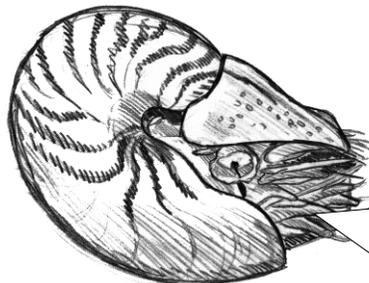


Octopus



Squid

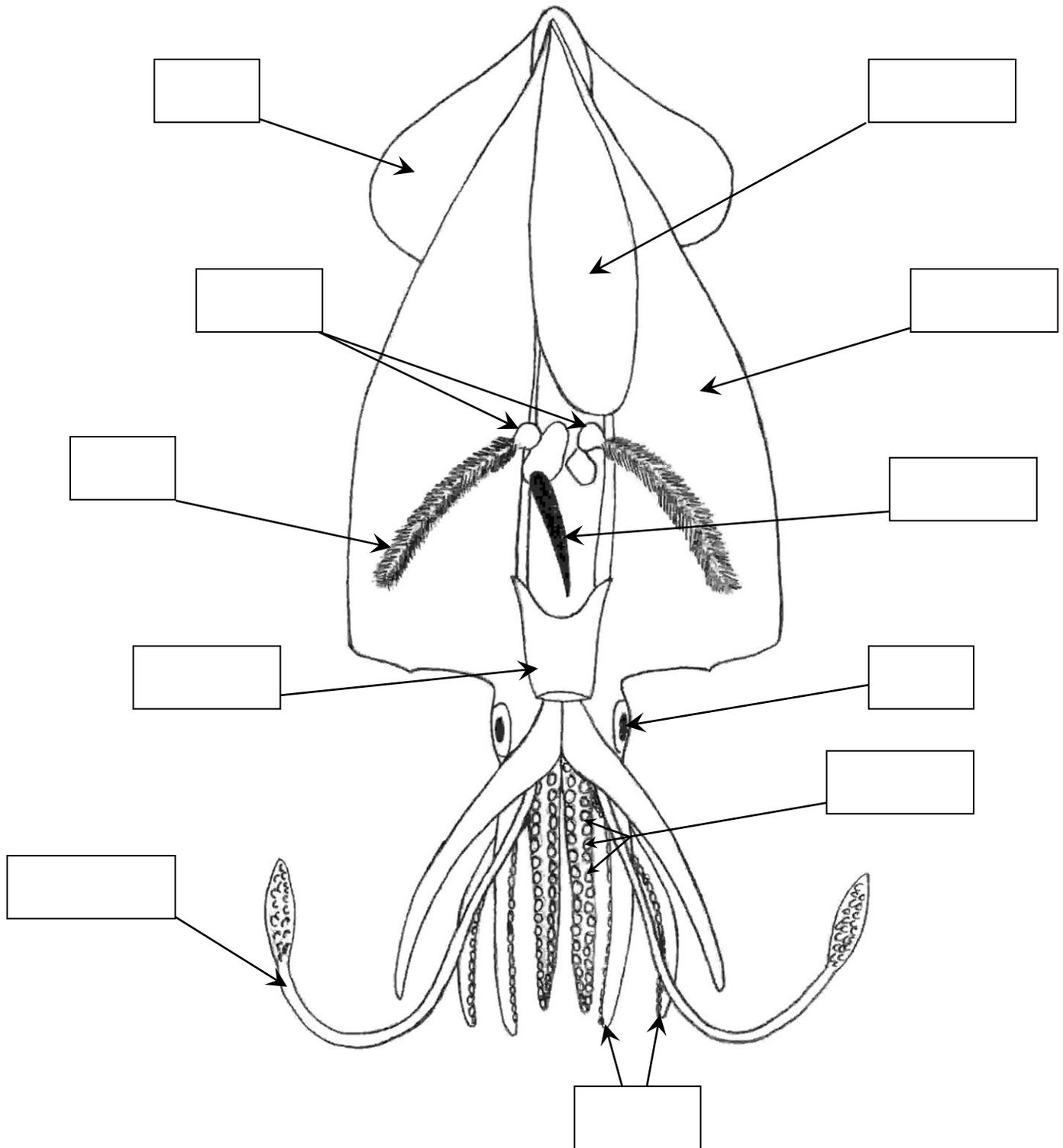
Cuttlefish



Nautilus



Label the parts of the squid as we discover them:





# Post Session Activity Ideas

## Math

1. In a school of 50 squid, how many arms are there?
2. In a school of 56 squid how many eyes are there?
3. If a squid can catch one shrimp with each tentacle, how many shrimp could 10 squid catch at once?
4. If the same group of ten squid were catching shrimp and one squid who was missing a tentacle joined the group how many total shrimp could they catch?
5. A school of 200 herring is attacked by a large squid. The squid eats 65 herring. How many herring are left?
6. A school of capelin was attacked by a school of 20 squid, and 180 capelin were eaten by the squid. If each squid ate the same number of capelin, how many capelin did each squid eat?
7. How many hearts are there in a school of 117 squid?
8. A group of 3 researchers are studying a school of 201 squid. How many squid are there for every one researcher?
9. Forty squid are traveling the ocean. How many gills do they have amongst them?
10. If a researcher counts 48 eyes what is the least number of squid she could be viewing? What is the greatest number of squid she could be viewing? Why is she unable to tell for sure?

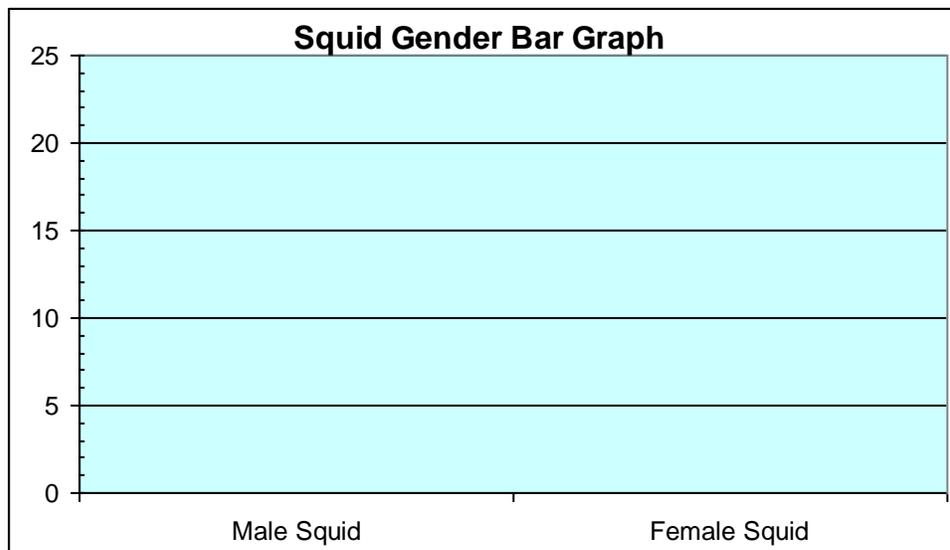
## Research

A. Have your students research one of the following topics and give a short report on their findings. Use the additional resources listed in the document to point students in the right direction.

- How do octopus eyes work? Who has more advanced eyes, insects or cephalopods?
- How do squid change color?
- What do scientists know about the giant squid?
- Is it hard to keep an octopus in an aquarium?
- What color is cephalopod blood, and why is it different from ours?
- Describe how and why cuttlefish are collected for their internal shells.

### B. Bar Graph

Count the number of male squid and female squid from the class's dissection. As a class, graph the results:



Ask the students whether any conclusions might be made from these results.

If you have any frozen squid left, distribute them. Ask students to make assumptions about how many are male and how many are female. Are there any external clues?

Have the students cut the squid open and graph the new results. Does this change any of their previous conclusions or assumptions?



## Social Studies

Students can research the various products around the world that come from cephalopods. Write about the value and diversity of each product and determine which countries produce, market, and use cephalopod-based products. Some examples to get students started might include ink, calamari, cuttlebones for bird cages, and Nautilus shells.

## Art

Students can learn about pressure and physics while watching these trained octopuses!

### Materials

Piece of colored cellophane; Eye dropper; A clear, squeezable plastic bottle with a screw-on cap

### Directions

Cut a round octopus with eight arms from the piece of colored cellophane. Cut a hole in the middle and put the dropper through the hole. Fill the eyedropper with water until it would barely float in water. Fill your squeezable plastic bottle to the very top with water and place your octopus inside. Tightly screw on the top of the bottle.

### What to Do and Why it Works

When you squeeze the bottle the octopus will descend. When you relax your grip the octopus rises again. Squeezing raises the water pressure inside the bottle, which in turn compresses the small bit of air inside the dropper's rubber bulb. The compressed air is denser, and the dropper starts to sink. When the bottle is released, the air bubble expands and the dropper floats back up. For added enrichment have your students research the principles behind the trained octopus and have them explain how it works. Students can also look at how this type of movement is similar to and different from jet propulsion.

## Theater/Physical Education

Hold an eight-legged octopus race. Have four students stand back to back and link arms to make an eight legged octopus. Have each "octopus" race other "octopuses" to see who is the fastest.

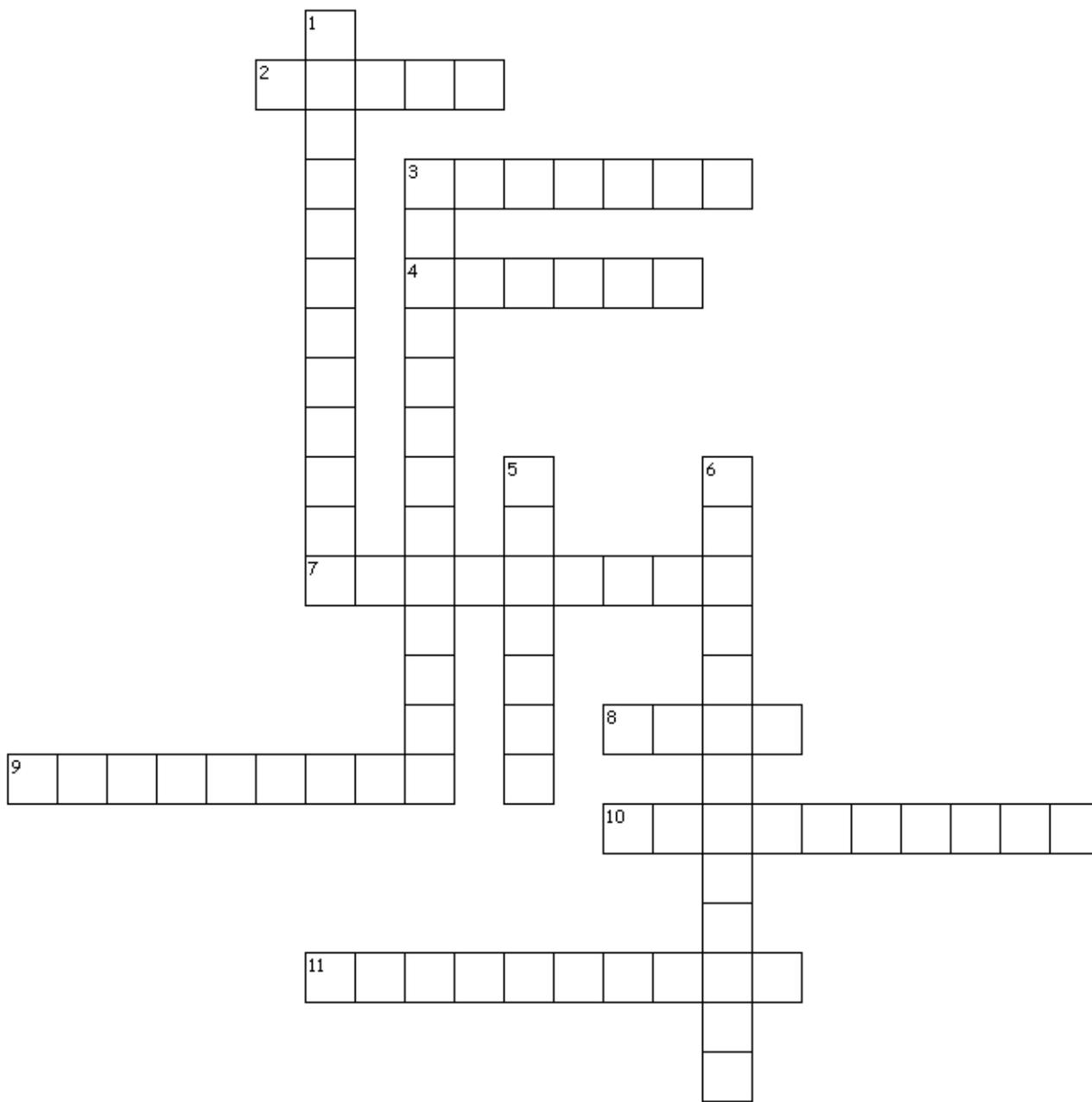
## Language Arts

Calamari is squid. Give your students the chance to taste a bit of calamari. Have them use their writing skills to write a food review. Discuss descriptive words and ways of "showing" not telling in writing.



# Vocabulary Wrap-Up

## The Jet Set





## **“The Jet Set” Criss-Cross Clues**

### **Across**

2. Parts of the shell in the nautilus that separate the different chambers
3. Dead animals
4. Tongue lined with teeth, used for digging meat out of prey (some species can use the “blank” like a drill to pierce tough shells)
7. Cord of tissue that runs through all the chambers in the nautilus; used to control gas level in each chamber
8. Mouthpart used for crushing shells
9. The bottom surface where an animal lives, e.g. sand, gravel, rock, woody debris, etc.
10. Movement based on Newton’s 3rd law-every action has an equal and opposite reaction; water is forced out of the siphon to propel the animal in the opposite direction
11. Moving the fins in a wave-like pattern for movement

### **Down**

1. Third right arm of the male octopus used for reproduction; a groove is found down its length and the suckers do not continue all the way to the end
3. Pigment patches that allow cephalopods to change their color
5. Having two cycles
6. Packet of sperm that is transferred from the male to the female



## ANSWER KEYS

### Math Madness

1. 400
2. 112
3. 20
4. 21
5. 135
6. 9
7. 351
8. 67
9. 20
10. 24-48

### “The Jet Set” Criss-Cross

#### Across

2. Septa
3. Carrion
4. Radula
7. Siphuncle
8. Beak
9. Substrate
10. Jet propulsion
11. Fin undulation

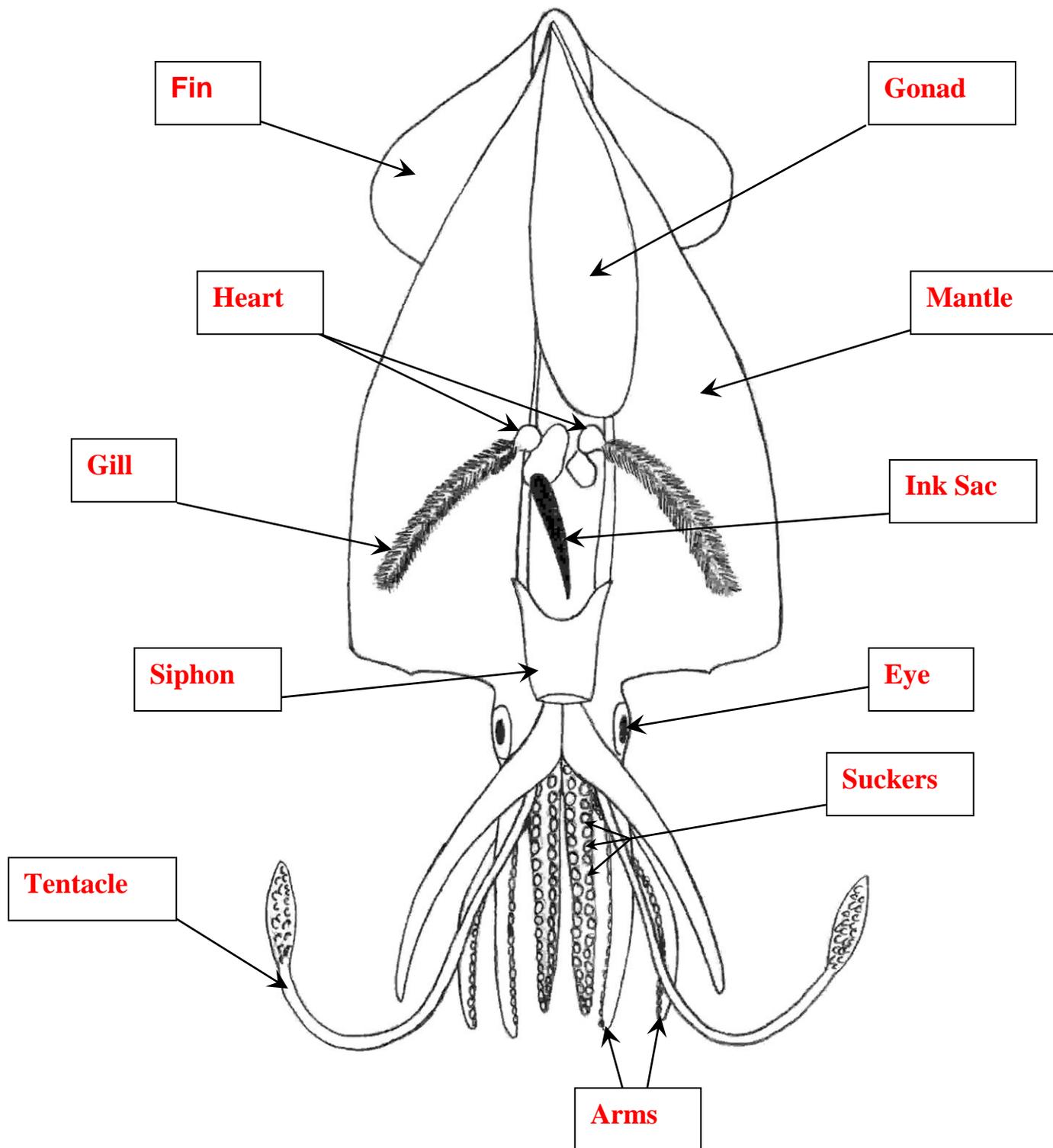
#### Down

1. Hectocotylus
3. Chromatophore
5. Diurnal
6. Spermatophore



		Defining characteristics
<b>KINGDOM:</b>	<b>Animalia</b>	Multi-cellular, mobile (at some point in life cycle), can't produce their own food, no rigid cell walls
<b>PHYLUM:</b>	<b>Mollusca</b> <i>(includes clams, snails, mussels, oysters...)</i>	Soft-bodied, bilateral symmetry, muscular foot, mantle, siphon  (Most have shells, radula)
<b>CLASS:</b>	<b>Cephalopods!</b>	<b>Head-footed, foot modified into arms and tentacles, siphon allows jet propulsion</b>

<b>The Four Main Types of Cephalopods</b>			
<b>CEPHALOPOD</b>	<b>ARMS</b>	<b>TENTACLES</b>	<b>SHELL</b>
<b>Octopus</b>	<b>8</b>	<b>0</b>	<b>NONE</b>
<b>Squid</b>	<b>8</b>	<b>2</b>	<b>INTERNAL "PEN"</b>
<b>Cuttlefish</b>	<b>8</b>	<b>2</b>	<b>INTERNAL "CUTTLEBONE"</b>
<b>Nautilus</b>	<b>0</b>	<b>Up to 90</b>	<b>EXTERNAL SHELL</b>





# Additional Resources

## Books

Blaxland, Beth. 2002. *Cephalopods: Octopuses, Squids, and Their Relatives (Invertebrates)*. Chelsea House Publications, New York.

Ellis, Richard. 1998. *Giant Squid, the Biology and Mythology of the World's Most Elusive Sea Creature*. Penguin Books, New York.

Lindeen, Carol. 2005. *Octopuses*. Capstone Press Inc. Chicago.

## Internet

National Resource Center for Cephalopods  
[www.nrcc.utmb.edu/](http://www.nrcc.utmb.edu/)

The Octopus News Magazine Online  
[www.tonmo.com/](http://www.tonmo.com/)

Cephalopod Information  
[www.thecephalopodpage.org/](http://www.thecephalopodpage.org/)  
[www.abc.net.au/science/ocean/default.htm](http://www.abc.net.au/science/ocean/default.htm)  
[www.australiancephalopods.com/](http://www.australiancephalopods.com/)  
<http://www.chemistrydaily.com/chemistry/Hemocyanin>

## Video Clips

[www.oceanfootage.com/stockfootage/Cuttlefish/owner%3Dskipstubbs](http://www.oceanfootage.com/stockfootage/Cuttlefish/owner%3Dskipstubbs)  
[www.oceanfootage.com/stockfootage/Cuttle\\_Flamboyant\\_Invertebrate/](http://www.oceanfootage.com/stockfootage/Cuttle_Flamboyant_Invertebrate/)  
[www.kararu.com/multimedia/dive-videos.html](http://www.kararu.com/multimedia/dive-videos.html)  
<http://www.cephbase.utmb.edu/>