Name: _____

Section: _____

Date: _____

Chapter 14 – Lab/Activity #3

Coastal Ecosystems: Shrimp – Versatile Coastal Critters

Introduction:

Shrimp are very common marine arthropods that rely on both the coastal ecosystems and open sea for survival. They are a commercially important species both as food and as bait. Shrimp have both anatomical and behavioral adaptations for survival in these ecosystems.

Materials:

- Live shrimp
- Dead shrimp (market fresh is best) or preserved specimens
- Shallow salt water aquarium with sandy bottom
- Dissecting pan and kits (or clean kitchen supplies, paper plates, disposables)
- Gloves
- Stereoscopes or hand lenses
- Hand net
- Fish food
- One liter of bottled (salt-free) or dechlorinated water (tap water left out uncovered for 24 hours)
- Five styrofoam cups
- Five lids for cups (plastic lids or aluminum foil)
- Marking pencil
- 100 mL graduated cylinder
- Balance
- 40 g synthetic sea salts (available in pet stores)
- Four containers with lids to store salt solutions
- 0.5 g brine shrimp eggs (available in pet stores)
- Five eye droppers or pipettes marked for 0.5 mL
- Colored pencils

Learning Outcomes:

After completing this lab activity and studying Chapter 14, Coastal Ecosystems, you should be able to:

1. Diagram and identify the external anatomy of a shrimp.
2. Describe the characteristics of the ecosystem for which shrimp is best adapted.
3. Describe behaviors of live shrimp.
4. Deduce functions of shrimp body parts from their anatomy.
5. List the behavioral and physical adaptations shrimp have for survival.
6. Describe factors necessary in the environment for the survival of shrimp.
7. Explain how shrimp affect human populations.
8. Give examples of how shrimp are an interdependent part of the ecosystem.

Safety Issues:

1. Sharp Hazard: Use common sense practices with sharp dissection tools or knives and scissors. Always point them away from others.
2. Allergy alert: Some people are extremely allergic to shrimp. Report any concerns to your teacher.
3. Glass hazard: You will be using glassware. Handle with care and report any incidents to your teacher.

Instruction(s) for Teacher:

An interesting extension to this lab might be to acquire market-quality shrimp, use plastic disposable and kitchen tools for dissection on paper plates, boil the shrimp and eat them. Use the internet for detailed instructions and advice on various methods of preparing shrimp, the best ones to buy and food safety when handling shrimp. This is an opportunity for parent involvement also and "take out" from a local reputable seafood restaurant may be an interesting option. Keep in mind that some individuals may have shrimp allergies and be aware of this before the lab.

Vocabulary:

Abdomen – in an arthropod this is the area behind the thorax that contains the internal organs.

Adaptation – an alteration or adjustment in structure or habits by which an organism improves its condition in relationship to its environment.

Antennules – short appendages attached to the head region of an arthropod, used for sensing the immediate environment-if they are long they are referred to as antennae.

Anterior – the head end of an animal.

Arthropoda – the invertebrate phylum within the kingdom Animalia characterized by animals with jointed legs and segmented bodies such as insects, crabs, lobsters and shrimp.

Benthic – living on or near the bottom of the ocean.

Brackish – water that is a mix of freshwater and seawater in no defined ratio.

Carapace – in arthropods this is a hard chitinous plate covering the head and thorax.

Procedure:

1. Research Question(s):

What adaptations do shrimp have that help them survive in coastal and open sea ecosystems?

2. Literature Review:

Of all the invertebrates, you've got to love the shrimp. There are more than 2000 species of these small aquatic animals and they come in a wide range of colors and occupy many different niches. Shrimp are found worldwide and in habitats ranging from the deep-sea hydrothermal vents to the coral reefs and mangrove swamps. Some shrimp spend their lives in the open sea and are nekton while others are benthic burrowing crawlers. Shrimp play an important role in the aquatic food web as well as an important role in the human food web and economy.

Classified in the Phylum Arthropoda due to their exoskeleton and their jointed legs they are cousins to insects but are more closely related to lobsters and crabs and join them in the class Crustacea. Anatomically they are similar to crabs and lobster but have bodies that appear more compressed laterally. Their exoskeleton forms a shield or carapace over their fused head and torso region (cephalothorax). The abdomen is segmented and flexible so that the tail can rapidly flex for a powerful backward swimming stroke (very powerful for a three inch animal!). Shrimp have eight pairs of legs on their thorax used for walking and food manipulation. The last five pairs of legs are called pereiopods which end in small pincers. Another five pairs of appendages called swimmerets are attached to the segments of the abdomen and are used for swimming, burrowing and egg-carrying in females. Shrimp have acute senses of sight, taste and touch with their compound eyes and antennae. Shrimp are also found in various colors-deep red, striped, green, brown, pink and nearly transparent. Clearly, they are adapted for a multitude of habitats and ecosystems.

Green and brown morphs of shrimp are particularly suited for the benthic life. They also tend to be scavengers who feed on the remains of other organisms. Deep-sea shrimp are equipped with light producing photophores and are deep red in color that serves as camouflage if they migrate up to dimly lit regions. Cleaner shrimp (such as Pierre in the popular film "Finding Nemo") live on coral reefs and serve as groomers for fish, eating debris and parasites from their scales. Pink, brown and white shrimp are the commercially most important shrimp because they are caught for human consumption. These three types of shrimp are a living link between the estuarine coastal ecosystems and that of the open sea. These shrimp spend their youth in the nurseries of the warm

coastal regions and adulthood in the open water playing out an interesting life cycle.

A single female shrimp can lay a million eggs in a single spawning out in open water. The tiny eggs hatch and the larvae are called nauplius. The nauplius grows over several weeks through several stages of development all the while a part of the floating planktonic community, changing shape as they grow. They rely on currents to transport them to nearshore brackish waters. Once there, these post-larval creatures give up planktonic drifting and become members of the benthic community. When they reach adulthood they return to the deeper offshore waters to spawn and live out their retirement dreams.

Ecosystems as you know are all about the relationships between organisms and the nonliving components of the environment in which they live. There are several abiotic factors in these ecosystems which influence the size of the shrimp population but the most important are water temperature and salinity. What the influences are on the abundance of shrimp year to year is an important question for shrimpers, and governmental agencies. Over 125,000 tons of shrimp are caught in the United States per year and government agencies often debate whether limits should be placed on harvesting these animals.

Water temperatures above 20 degrees C promote the growth of young shrimp. And while shrimp are resilient to changes in salinity, too much freshwater runoff from spring flooding in coastal areas results in poor conditions for shrimp populations.

Shrimp Anatomy:

- The head and thorax are fused into a carapace or cephalothorax that is laterally compressed.
- The rostrum is a pointed protrusion on the head.
- There are three sets of appendages in the head area: eyes on eye stalks, a long pair of antennae, and a short pair of antennules.
- The cephalothorax has eleven other appendages, the last five are called walking legs.
- Anterior to the walking legs are the maxillipeds and maxillae that can cut up food into tiny pieces.
- Posterior to the cephalothorax is the abdomen that is made up of about six segments.
- Attached to the abdomen are swimmerets.
- The last segment of the abdomen is called the tail fan that is made up of a modified pair of swimmerets called uropods and a telson (a sharp appendage).

Vocabulary *(continued)*

Cephalothorax – a fused head and thorax found in some species of animals.

Crustacea – the class within in the phylum Arthropoda in which all are decapods (have five pairs of thoracic legs) and a fused cephalothorax protected by a carapace made of chitin.

Detritus – bits of organic matter.

Dorsal – back

Maxillipeds – in shrimp these are the three anterior pairs of large leg-like appendages that separate out food particles that may be picked up.

Pereiopods – in shrimp there are five pairs of appendages located posterially to the maxillipeds that are primarily used for walking or clinging. These legs may be long and delicate.

Posterior – the tail end of an animal.

ppt – parts per thousand, a measure of salinity.

Rostrum – in crustaceans this is an anteriorly pointing spine that juts forward from the carapace.

Spawning – releasing eggs and sperm into the water or it can also mean releasing many eggs into the water after fertilization.

Swimmerets – short, stout appendages used for swimming that are attached to the ventral surface of the first five abdominal segments. They are also called pleopods.

Telson – a sharp appendage located on the tail of the shrimp.

Uropods – modified swimmerets form this tail section of the shrimp.

Ventral – front

3. Hypothesis:

Based on the research question(s) and the literature review write your hypothesis/prediction(s) below:

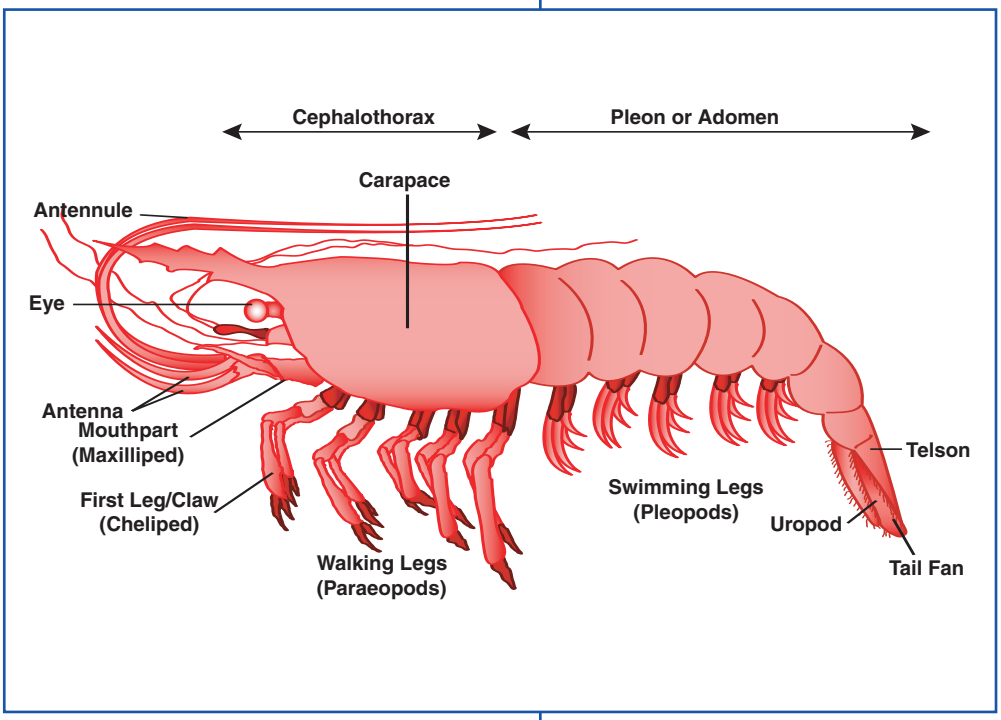
Answers vary. Students should say something such as: Shrimp have physical adaptations such as a powerful tail stroke for escaping predation as well as acute senses. Shrimp can tolerate a range of salinity.

4. Activity:

Station 1: Exploring Anatomy

Acquire a shrimp and dissecting tools. If available observe various parts of your shrimp with the stereoscope. Observe and check off each of the following body parts, then answer the observational prompts in the data section for Station 1.

- The head and thorax.
- The rostrum.
- Eye stalks, antennae, and antennules.
- Cephalothorax has eleven other appendages, the last five are called walking legs.
- Anterior to the walking legs are the maxillipeds and maxillae that can cut up food into tiny pieces.
- Posterior to the cephalothorax is the abdomen that is made up of about six segments.
- Attached to the abdomen are swimmerets.
- The last segment of the abdomen is called the tail fan which is made up of a modified pair of swimmerets called uropods and a telson (a sharp appendage).
- Cut away a section of carapace behind the legs. Look for feathery spongy structures called the gills.



Station 1: Data Collection

Draw a diagram of your shrimp. Using numbers label at least five parts you have discovered by dissection.

Print the name of the labeled part next to the appropriate number.

1. _____
2. _____
3. _____
4. _____
5. _____

Observation statement: What did you observe?

Answers vary, but can include a compound eye, rostrum, carapace, swimmerets or walking legs.

Station 2: Observing Behavior

1. Your teacher has set up an aquarium with live shrimp. Observe them for several minutes and watch their interactions.
2. Try to observe feeding. It may be necessary to make available a small amount of fish food if they are not already feeding.
3. Try to observe swimming, escaping, and hiding behaviors. The shrimp may exhibit these behaviors as they interact or you may have to provide some gentle stimulus. Be aware that the shrimp can see you. If you cast a shadow over the tank they will react unless they have already been conditioned. They may also react to light tapping on the glass of the aquarium. Do not stick your hands in the water or put any objects into the water without teacher permission.
4. Draw the behaviors that you observed. Use arrows on your drawings to show directions of movement.

Station 2: Data Collection

Draw each of the behaviors listed in the chart:

Activity	Diagram
Feeding	
Swimming	
Escaping	
Hiding	

Instruction(s) for Teacher:

Student drawings should show the use of appendages for feeding, swimmeret use in swimming, and escape behavior that may include rapid acceleration and burrowing for hiding.

Observation statement: Describe the general patterns of behavior you observed in the table below.

Activity	Diagram
Feeding	*Shrimp bring bits of food into their mouths with walking legs as well as maxillae and maxillipeds.*
Swimming	*Shrimp can swim forward and backward using their swimmerets and tail.*

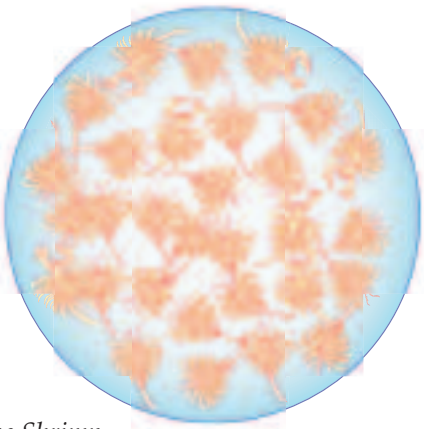
Instruction(s) for Teacher:

You will need to prepare four salt solutions for this experiment. Use only dechlorinated water.

1. Prepare the 80 ppt solution by adding 40 g of sea salt to 500 mL of water. Label the container "80 ppt"
2. To make the 60 ppt solution, add 150 mL of the 80 ppt to 50 mL of water. Label the container "60 ppt"
3. To make the 40 ppt solution, add 100 mL of the 80 ppt to 100 mL of water. Label the container "40 ppt"
4. To make the 20 ppt solution, add 50 mL of the 80 ppt to 150 mL of water. Label the container "20 ppt"
5. Put lids on all the containers. Evaporation of the water will change the concentrations of salt in your solutions.
6. Label five plastic-foam cups : 0 ppt, 20 ppt, 40 ppt, 60 ppt and 80 ppt.
7. In the cup labeled 0 ppt, pour in 200 mL of fresh water. This is the control.
8. Pour 200 mL of each solution in the appropriate cup.
9. Put 0.1 g of brine shrimp eggs in each cup. Cover the cups with lids or foil and place in an undisturbed area. This day is referred to as day 0.

Station 3: Salinity and Egg Hatching

1. Your teacher has prepared four salt solutions with brine shrimp for this experiment. Each day for two days use a dropper to stir and then remove 0.5 mL of solution from each cup containing various salt solutions and brine shrimp eggs. Each cup has a different dropper so that the solutions do not become contaminated. Double check that you are using the correct dropper for the correct cup!
2. Be certain to stir the solution thoroughly to mix the eggs and hatchlings evenly in the solution.
3. Place the 0.5 mL sample in a Petri dish and examine it under a stereoscope or with a hand lens.
4. Count the number of hatched shrimp and eggs and record the results.
5. Dispose of the sample as directed by the teacher. Do not return the sample to the cup.



Hatched Brine Shrimp

Station 3: Data Collection

Record the number of eggs and shrimp observed each day for each salt solution.

	0 ppt		20 ppt		40 ppt		60 ppt		80 ppt	
	Eggs	Shrimp	Eggs	Shrimp	Eggs	Shrimp	Eggs	Shrimp	Eggs	Shrimp
Day 0										
Day 1										
Day 2										

Observation statement: What difference did you observe in the numbers of hatched eggs between the different salt solutions?

They are not expected to hatch in 0 ppt and numbers should be optimum in 40-60 ppt salt solution.

Analysis of Results:

Interpret and analyze your results for each station by answering the following question(s).

Station 1: Exploring Anatomy

1. What might the function of the rostrum be?

   Defense.

2. What is the function of the stalked eyes?

   Sight and sensing.

3. What might the function of the antennae and antennules be?

   Long and short range sensing.

4. What might the function be of the walking legs that have pincers?

   Getting food and defense.

5. Which part of the shrimp is eaten?

   Abdomen.

6. What might be the function of the swimmerets?

   Mobility.

7. What might be the function of the uropods?

   Swimming.

8. What might be the function of the telson?
   Swimming, used as a rudder and quick acceleration.

9. List several physical adaptations shrimp have for protection:
   Rostrum, pincers, telson and exoskeleton.

Station 2 : Observing Behavior

1. How do shrimp hide from their enemies?
   They bury themselves in the sand.

2. What sticks out above the sand?
   Eye stalks.

3. Why?
   The eye stalk allows the shrimp to observe their environment.

4. What is their normal method of swimming?
   Using swimmerets.

5. Can they swim in more than one direction?
   Yes, they can move backwards and forwards.

6. Using what?
   Swimmerets or telson.

7. List several behavioral adaptations shrimp have for protection.
   Burrowing, ability to swim backwards, eyestalks.

Station 3: Hatching Eggs in Solutions with Different Salinity

1. Which cup had the most salt?
   80 ppt

2. Which cup had the least salt?
   0 ppt

3. What is the effect of salinity on the hatching of brine shrimp?
Although tolerant to a wide range of salinity, brine shrimp have an optimal salinity for hatching. There will be little, if any, hatching in freshwater. Hatching will rise at the optimal salinity rate (likely 30-50 ppt) and then decline again as the water gets more saline.

4. Name another abiotic factor that you could vary that might influence the hatching of brine shrimp.
Temperature

5. Describe two factors that influence how saline the coastal waters are and what effect could they have on the shrimp population?
Freshwater runoff could lower the shrimp population. If the water is too cool the population will decrease.

Conclude and Communicate:

1. The research question(s) for this activity:
What adaptations do shrimp have that help them survive in coastal and open sea ecosystems?

2. Your hypothesis/prediction(s) for this activity:
Hypothesis/prediction(s) should be the same as at the start of the activity. Shrimp have physical adaptations such as a powerful tail stroke for escaping predation as well as acute senses. Shrimp can tolerate a range of salinity.

3. Was your hypothesis supported by the data? Why or why not?
The hypothesis is supported by the data. Support is illustrated by the data from the salinity and hatching study as well as from live shrimp observation. Shrimp have a variety of adaptations to cope with the environment in which they live such as keen senses, the ability to burrow, and a resilience to changes in salinity.

4. Write two new research questions based on what you have learned from this activity.

Answers vary. Students should ask questions such as:

1. What is the effect of temperature on brine shrimp hatching?

2. What is the effect of salinity changes on adult shrimp?

5. The value and importance of this activity to the study of science:

This activity is important because it demonstrates how salinity can affect organisms. If, for example, a sensitive ecosystem such as an estuary is inundated with freshwater it will alter the balance of life. Brine shrimp are especially important because they closely simulate organisms in these brackish environments and are easy to work with in a controlled environment.