

# RESOURCES



**LABORATORY HELPFUL HINTS**

**LABORATORY SUPPLIES LIST**

**SCIENCE SUPPLY COMPANIES**

**CAREERS IN MARINE SCIENCE**

**VIDEOS & DVDS/RESEARCH VACATIONS**

**MARINE SCIENCE WEB SITES**

**ANSWER KEY FOR TESTS BOOKLET**



## Laboratory Helpful Hints

### LABORATORY INVESTIGATION 1

#### *Making Ocean Water*

- Sea salts can be purchased from a biological supply house. (See list of supply houses provided at the end of this manual.) You can also purchase sea salts (“instant ocean”) at aquarium/pet supply shops.
- If a triple-beam balance is not available, any metric scale will do.
- The “artificial seawater” prepared in this lab may lack some trace elements found in natural seawater; nonetheless, it is suitable for keeping marine organisms in a classroom saltwater aquarium.

### LABORATORY INVESTIGATION 2

#### *Measuring the Speed of a Snail*

- The mud snail *Ilyanassa* is an excellent choice for this lab. The marsh snail (periwinkle) *Littorina*, or any other small intertidal species native to your area, can also be used.
- The best results are obtained when snails are used as soon as possible after being freshly taken from the shore.

### LABORATORY INVESTIGATION 3

#### *Examining Beach Sand*

- Try to provide your students with a variety of sand samples, including coral sand, black sand from a volcanic island, and beach sand from a rocky coast. (See article, “Sands of the World,” by Mack and Leistikow, noted in the Suggested Readings list for this chapter.)

### LABORATORY INVESTIGATION 4

#### *How Diatoms Perform Their Life Functions*

- If you want your students to examine fresh diatoms, you will need to do a plankton tow before class or on the preceding day. Otherwise, you can use prepared slides of diatoms, which can be purchased from one of the biological supply houses listed in this manual.

### LABORATORY INVESTIGATION 5

#### *Adaptations of a Marine Alga*

- Rockweed (*Fucus*) can be removed from rocks at low tide and placed in buckets of seawater. Refrigeration will help keep it fresh.

### LABORATORY INVESTIGATION 6

#### *Observing Diverse Zooplankton*

- Live zooplankton, including copepods, arrow worms, and larvae of marine invertebrates, can be obtained from a plankton tow. If you hold the collecting tube up to the light, you will see copepods darting about in the water.
- Prepared slides of copepods can be purchased from one of the biological supply houses listed in this manual.
- Time limitations will not permit your students to make detailed drawings of the zooplankton. Have them make basic sketches of what they see; more detailed drawings can be done with the aid of a book.
- If the zooplankton are moving too fast to be well-observed, they can be slowed by using a clear viscous fluid called methyl cellulose. Dip a toothpick in the *methyl cellulose* and make a ring in the middle of the slide. Place two drops of the water that contains zooplankton in the middle of the ring. Apply a cover slip. The zooplankton will swim into the methyl cellulose and be slowed.

**LABORATORY INVESTIGATION 7*****Observing Stinging Tentacles***

- This lab is a very challenging one, because not all tentacles will discharge their nematocysts in response to chemical stimulation. You may want to challenge your students by offering extra credit to anyone who can show discharging nematocysts. Use a bioscope or a video camera, if available, to project an image of the specimen on a screen or monitor for the whole class to see.

**LABORATORY INVESTIGATION 8*****Adaptations of the Sandworm***

- This lab cannot be completed in one 40-minute period. It should be carried out in two sessions: external anatomy and internal anatomy. Follow procedures 1 to 5 for external anatomy and 6 to 15 for internal anatomy.
- Sandworms (*Nereis*) can be purchased from a biological supply house (see the Science Supply Companies list in this manual) or from a marine bait shop.

**LABORATORY INVESTIGATION 9*****Feeding in a Bivalve***

- Observing the beating of cilia in the gill membranes of a bivalve is challenging and exciting. You can obtain live mussels or clams from a fish market; or, mussels can be removed from the rocks along a shore at low tide. Keep them in refrigerated water before using; bivalves stay alive longer in cold water because it holds more oxygen than warm water does.

**LABORATORY INVESTIGATION 10*****Adaptations of Crabs***

- Any of the common shore crabs, e.g., the lady crab, blue crab, rock crab, and stone crab, are large enough to use for observation of their body structures.

- Crabs can be caught along the shore or purchased in a fish market. Live crabs can be kept in an aquarium tank to demonstrate life functions. Dead crabs can be kept frozen for use in an anatomy lab.

**LABORATORY INVESTIGATION 11*****Adaptations of Sea Stars***

- Live sea stars can be obtained at low tide in the rocky tide pools along the shore. They also can be found attached to wharf pilings and at the base of rock jetties and groins in the subtidal zone. (You will need to snorkel to take specimens from the subtidal zone.) Live sea stars can also be purchased from biological supply houses (see the list provided in this manual). Obtain small to medium-sized sea stars.
- You should have at least one large (20-gallon), filtered saltwater aquarium tank set up to receive the live sea stars. They can be fed small pieces of frozen fish or you can open a fresh mussel or clam and leave it in the tank for them to eat. Do not overfeed!

**LABORATORY INVESTIGATION 12*****Breathing and Transport in a Fish***

- The killifish (*Fundulus*) is a very hardy fish and an excellent choice for this lab, but any small intertidal fish (or goldfish) will do. The fish can be caught in a dip net or seine net in intertidal marshes or along rock jetties, where fish tend to be more concentrated.
- Use of a glass slide to cover the fish's tail is not recommended, because students may accidentally cut the tail with the slide's edge.
- The fish will move its tail from time to time while you observe it through the microscope. Wait for the tail to stop moving and try again. Add a few drops of water to the tail.
- Instruct your students to observe the fish for no more than 10 minutes, then return it to the aquarium and try another fish.

- Instruct your students to wipe the stage and the objective lens clean of saltwater residue after performing the experiment.

### LABORATORY INVESTIGATION 13

#### *Adaptive Features of Marine Reptiles and Birds*

- Collect pictures of marine birds and reptiles ahead of time for this lab. Wildlife calendars are often a good source for photographs of ocean life.

### LABORATORY INVESTIGATION 14

#### *Diving Response in Humans*

- It is recommended that the entire head be submerged.
- The eyes should be closed during submersion for both groups.
- Earplugs are recommended for students prone to ear infections.
- Have towels available for students to dry themselves off.

### LABORATORY INVESTIGATION 15

#### *Determining Seawater Salinity*

- If you are using hot plates, plug them in prior to the start of class to save time. A hot plate takes longer to boil water than a Bunsen burner does. Using a hot plate, it will take about 10 minutes to boil off 20 mL of water in a 100 mL beaker.
- Be careful that salt does not splatter out as the remaining water boils off. Turn down the heat or cover the beaker with a cooling pad.

### LABORATORY INVESTIGATION 16

#### *Getting Water from a "Stone"*

- To save time, use the Bunsen burner instead of the hot plate, because the burner heats much faster.

### LABORATORY INVESTIGATION 17

#### *Analyzing Ocean Temperatures*

- You will have to make photocopies (preferably slightly enlarged) of the two maps from this lab and give them to your students. The maps should accompany the students' lab reports when handed in.

### LABORATORY INVESTIGATION 18

#### *Effects of Temperature and Salinity on Water Density*

- Provide your students with photocopies (preferably enlarged) of the lab's Temperature/Salinity Diagram, which should be handed in with their lab reports.

### LABORATORY INVESTIGATION 19

#### *Identifying Pigments in Algae*

- Use 100 percent absolute alcohol (denatured) as a solvent.

### LABORATORY INVESTIGATION 20

#### *Measuring Ocean Waves*

- Have your students copy the Wave Characteristics Table into their notebooks (to be included in their lab reports).

### LABORATORY INVESTIGATION 21

#### *Observing How a Barnacle Filter Feeds*

- You can find live barnacles along the shore at low tide, attached to a variety of substrates. Do not scrape barnacles from the rocks, as scraping will kill them. Instead, find barnacles that are attached to small objects such as shells or pieces of wood, which can be put into containers to be observed. In particular, look for barnacles that are attached to the shells of ribbed mussels.

## LABORATORY INVESTIGATION 22

### *Determining the pH of Water Samples*

- The pH paper may not be able to show a noticeable color difference between the fresh-water and ocean-water samples, since the differences in pH between the two may be only one pH unit. A pH meter, if available, with a digital readout of two decimal points, would give much more accurate readings.

## LABORATORY INVESTIGATION 23

### *Analyzing Fishery Data*

- Provide your students with graph paper, which will be collected (when graph is completed) along with the lab report.

## Laboratory Supplies List

The laboratory investigations in the textbook require the materials listed below. The list is based on a class of about 30 students, which can be divided into ten groups, with three students in each team. Most of the equipment listed is for use in the laboratory investigations. Some of the items listed are needed to set up a marine aquarium for the classroom.

- |   |                         |
|---|-------------------------|
| 1 package of Whatman's filter paper                 | 10 probes               |
| 5 mortar-and-pestle sets (60-mL capacity)           | 10 scissors             |
| 1 bottle of 95% denatured alcohol                   | 10 hand lenses          |
| 10 compound light microscopes                       | 10 petri dishes         |
| 5 dissecting microscopes                            | 10 forceps              |
| 5 vials of pH red litmus paper                      | 10 cooling pads         |
| 5 vials of pH blue litmus paper                     | 10 Bunsen burners       |
| 10 packages of pH hydriion paper                    | 15 medicine droppers    |
| 10 porcelain (50-mL) evaporating dishes             | 10 iron rings           |
| 10 hydrometers/thermometers                         | 10 iron ring stands     |
| 10 100-mL graduated cylinders                       | 35 safety goggles       |
| 10 50-mL graduated cylinders                        | 5 triple-beam balances  |
| 5 10-mL graduated cylinders                         | 10 dissecting needles   |
| 10 wire-mesh heating pads                           | 10 pads of lens paper   |
| 10 transparent metric (mm) rulers                   | 1 plankton net          |
| 1 bottle of carmine powder                          | 1 seine net with poles  |
| 10 prepared slides of copepods                      | 5 aquarium dip nets     |
| 1 package of absorbent cotton                       | 1 aquarium filter       |
| 10 prepared slides of diatoms                       | 10 dissecting trays     |
| 1 order of live zooplankton                         | 1 order of live diatoms |
| 1 bottle of methyl cellulose                        | 1 (aquarium) air pump   |
| 10 prepared slides of dinoflagellates               | 1 bottle of vinegar     |
| 1 bottle of chlorophyll solution ( <i>Ulva</i> )    | 10 cork stoppers        |
| 1 bottle of solvent (for chlorophyll)               | 10 live barnacles       |
| 1 bag of beach sand                                 | 20 100-mm test tubes    |
| 10 preserved sandworms                              | 10 test tube racks      |
| 10 live marine (or freshwater) snails               | 1 watch/clock           |
| 5 boxes of color pencils                            | 10 spatulas             |
| 1 container of dried plankton (fish food)           | 10 tongs                |
| 1 package of thumb tacks or pins                    | 10 magnets              |
| 10 shallow bowls or containers                      | 10 live sea stars       |
| 10 samples of fresh <i>Fucus</i> (rockweed)         | 10 frozen crabs         |
| 12 live clams or blue mussels                       | 10 frozen clams         |
| 1 package of graph paper                            | 12 live killifish       |
| 10 preserved sandworms                              | 5 live sea anemones     |
| 1 bottle of food coloring                           | 1 20-gallon glass tank  |
| 1 bottle of hydrated copper sulfate                 | 1 plastic aquarium lid  |
| 1 box of microscope slides                          | 10 pairs of earplugs    |
| 1 box of microscope cover slips                     | 10 swim caps            |
| 1 bag of dolomite aquarium gravel                   | 2 rolls of paper towels |
| 1 bag of sea salts (to make 50 gallons of seawater) |                         |

## Science Supply Companies

Carolina Biological Supply Company  
2700 York Road  
Burlington, NC 27215  
Phone: 1-800-334-5551

Connecticut Valley Biological Supply Co., Inc.  
P.O. Box 326, 82 Valley Road  
Southampton, MA 01073  
Phone: 1-800-628-7748

Fisher Scientific Company  
4500 Turnberry Drive  
Hanover Park, IL 60133  
Phone: 1-800-955-1177

Frey Scientific Company  
P.O. Box 8101, 100 Paragon Parkway  
Mansfield, OH 44901  
Phone: 1-800-225-FREY

Hach Company  
P.O. Box 389  
Loveland, CO 80539  
Phone: 1-800-227-4224

Nasco Science Company  
901 Janesville Avenue  
Fort Atkinson, WI 53538  
*and*  
4825 Stoddard Road  
Modesto, CA 95356  
Phone: 1-800-558-9595

National Biological Labs, Inc.  
140-C Tewning Road  
Williamsburg, VA 23188  
Phone: 1-800-248-8830

Pasco Scientific Company  
P.O. Box 619011  
Roseville, CA 95661  
*and*  
10101 Foothills Blvd.  
Roseville, CA 95747  
Phone: 1-800-772-8700

Sargent-Welch Scientific Company  
P.O. Box 5229  
Buffalo Grove, IL 60089  
Phone: 1-800-SARGENT

Science Kit and Boreal Labs  
777 East Park Drive  
Tonawanda, NY 14150  
Phone: 1-800-828-7777

Scientifics Company  
60 Pearce Avenue  
Tonawanda, NY 14150  
Phone: 1-800-728-6999

Ward's Natural Scientific Establishment, Inc.  
P.O. Box 92912, 5100 West Henrietta Road  
Rochester, NY 14692  
Phone: 1-800-962-2660 (East coast)  
Phone: 1-800-872-7289 (West coast)

## Careers in Marine Science

In marine biology, the focus is on life in the sea. In oceanography, the physical aspects of the ocean are emphasized (unless biological oceanography is specified). In the working world, however, these branches of science often overlap in a variety of careers. What kinds of careers are available in marine biology or oceanography? Here are a few examples of jobs that are related to marine science, some of the educational backgrounds that can prepare someone for such careers, and an idea of what the jobs may actually entail.

**FISHERIES BIOLOGIST** This job requires a B.S. and an M.S. in fisheries biology and, for higher-level positions, a Ph.D. in fisheries science. A person with this background could do research for government agencies (such as the U.S. Fish and Wildlife Service) or for private industry. A fisheries biologist may also work as a consultant for an aquatic/civil engineering business, for example, on the possible effects of development projects on marine (or freshwater) fishes.

**CHEMICAL OCEANOGRAPHER** Possible educational backgrounds include a B.S. and an M.S. in environmental toxicology and a Ph.D. in chemical oceanography for higher-level positions. Career choices include working for a government environmental agency (such as the EPA) as a research scientist in a laboratory. The work may include developing methods for detecting toxic compounds that are present in the marine environment.

**MARINE ARCHAEOLOGIST** Educational background could include a B.S. in anthropology (archaeology) and an M.S. in nautical archaeology. Again, a Ph.D. enables access to higher-level research and/or teaching positions. Certification as a scuba diver would be needed for on-site fieldwork. Work might include excavations on such sites as underwater shipwrecks and sunken harbors.

**AQUACULTURE MICROBIOLOGIST** Aquaculture is the science of farming aquatic organisms for human consumption. Having a B.S. in microbiology could lead to a career doing aquaculture diagnostics and bioassays in an environmental laboratory.

**MARINE BIOLOGIST** Having a B.S. and an M.S. in biology, zoology, or specifically marine biology could lead to employment as a marine biologist. A Ph.D. leads to greater research and teaching opportunities. Possible employment may be research opportunities with universities or government agencies. An example of a government job is a marine biologist compiling a database of information on fisheries to be used in the management and conservation of coastal areas. Marine biologists can also study a variety of marine organisms in their natural habitat, anything from seaweeds to worms to whales.

**ENVIRONMENTAL EDUCATOR** With a B.S. in marine biology and an M.S. in a field such as environmental education, one might apply for a job as a marine/environmental educator for a state government research and education agency such as Sea Grant. Work may include coordinating beach cleanups, organizing marine mammal rescues, monitoring nesting sea turtles, and so on. Public aquariums also employ marine science specialists as educators for special programs geared to adults and children.

**UNDERWATER FILMMAKER** A background or degree in the fields of journalism, biology, and/or filmmaking could provide training for work in producing educational, environmental, and entertainment films and videos about the marine world. These films are popular for use on TV and in the classroom. You could be an independent filmmaker or work for a company.

**RESEARCH VESSEL CAPTAIN** A background in nautical science or oceanography would be useful for someone interested in a job as a ship's captain. Opportunities include working as a captain on a scientific research vessel that conducts worldwide research in such areas as marine biology, geochemistry, and seafloor features by use of a diving research submarine.

Other careers related to marine science include: marine geologist; high school marine science teacher; science writer specializing in ocean topics; naval architect; lifeguard; scuba diving instructor; physical oceanographer; and ocean engineer. Students can find out more about these careers in their school or local library, or on the Internet.

## Videos & DVDs/Research Vacations

### Marine Science Videos and DVDs

*Students and teachers can obtain the following videos and/or DVDs on marine science topics from:*

The Discovery Channel ([www.discovery.com](http://www.discovery.com)),  
Phone: 1-800-517-2344:

- “Air Jaws I” and “Air Jaws II” (re: predatory tactics of great white sharks)
- “Blue Planet: Seas of Life” (eight-episode series)
- “Chasing Giants: On the Trail of the Giant Squid”
- “Moby Dick: The True Story” (re: sperm whale and the whale-ship *Essex*)
- “Titanic” (two-part series)

The National Wildlife Federation/MacGillivray  
Freeman Films ([www.coralfilm.com](http://www.coralfilm.com)):

- “The Coral Reef Adventure”

The Nature Channel, Phone: 1-800-336-1917:

- “The Secret World of the Shark”

The National Geographic Channel, *National Geographic Today* (segment on overfishing)

The Public Broadcasting System (WGBH), *NOVA* ([www.pbs.org](http://www.pbs.org)), Phone: 1-800-255-9424:

- “Deep Sea Invasion” (re: spread of toxic alga *Caulerpa taxifolia*)
- “Incredible Suckers” (re: octopus and squid)

The Public Broadcasting System, *Scientific American Frontiers* ([www.pbs.org/saf](http://www.pbs.org/saf)):

- “Mysteries of the Deep” (re: famous submarines and their pioneering crews)

### Marine Science Research Vacations

*Students and teachers can participate, as volunteers, in “research vacations” with the following scientific organizations:*

Earth Island Institute

Sea Turtle Restoration Project  
([info@seaturtles.org](mailto:info@seaturtles.org)) and

Salmon Protection and Watershed Network  
([spawn@spawnusa.org](mailto:spawn@spawnusa.org))

EcoVolunteer Expeditions

40 Montezuma Avenue  
Forest Knolls, CA 94933  
Phone: 1-800-859-SAVE

EcoTeach Sea Turtle Research Expedition

([deb@ecoteach.com](mailto:deb@ecoteach.com))  
Phone: 1-206-713-8166

Oceanic Society Expeditions

([office@oceanic-society.org](mailto:office@oceanic-society.org))  
Fort Mason Center, Bldg. E  
San Francisco, CA 94123-1394  
Phone: 1-800-326-7491

## Marine Science Web Sites

*Students and teachers can research the following sites on the Internet to obtain up-to-date, scientific information about the condition of the ocean and its inhabitants.*

**National Ocean Service (at <http://noaa.gov>),  
a division of the National Oceanic and  
Atmospheric Administration (NOAA):**

Coastal and Ocean Resource Economics  
Coast Survey/Nautical Charts  
Coral Reef Information Service (CoRIS)  
Geodetic Data, Software, and Publications  
Groundfish Atlas  
(<http://www.orca.nos.noaa.gov>)  
The *JASON Project.org* (Dr. Robert Ballard)  
Marine Protected Areas  
National Marine Sanctuaries  
NOAA Coastal Services Center  
NOS MapFinder  
Ocean Explorer  
Oil & Chemical Releases Office of Response  
and Restoration  
Tidal and Current Information  
U.S. Coral Reef Task Force

**Additional marine science organizations and  
Web sites:**

American Fisheries Society ([www.fisheries.org](http://www.fisheries.org))  
FishBase ([www.fishbase.org](http://www.fishbase.org)) (re: commercial  
fisheries)  
Lamont-Doherty Earth Observatory Campus  
([Earth2Class.org](http://Earth2Class.org))  
Marine Stewardship Council ([www.msc.org](http://www.msc.org))  
(re: commercial fisheries)  
National Audubon Society  
([www.audubon.org/campaign/lo/seafood/  
cards.html](http://www.audubon.org/campaign/lo/seafood/cards.html))  
National Wildlife Federation ([www.nwf.org/](http://www.nwf.org/)  
*climate*) (re: fisheries and climate)  
Ocean Awareness ([http://www.cs.fsu.edu/  
projects/sp95ug/group1.7/ocean1.html](http://www.cs.fsu.edu/projects/sp95ug/group1.7/ocean1.html))  
The Ocean Conservancy ([www.cmc-ocean.org](http://www.cmc-ocean.org))  
(formerly the Center for Marine  
Conservation)  
Sea Around Us Project  
([www.saup.fisheries.ubc.ca](http://www.saup.fisheries.ubc.ca))  
World Wildlife Fund: Ocean Rescue  
([www.worldwildlife.org/oceans](http://www.worldwildlife.org/oceans))

