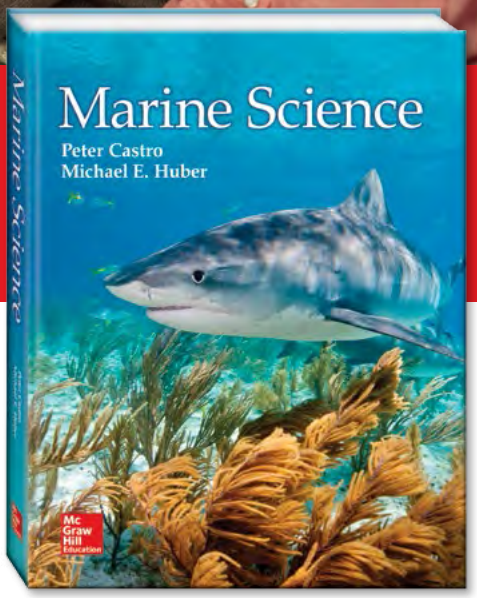
Take Your Students on a Deep Dive



Program Overview and Sample Guide

Welcome to *Marine Science*

Interest in the world ocean started for many of us in our youth. Our fascination probably started after watching a television documentary, visiting an Internet site on whales or El Niño, or perhaps a visit to a marine theme park. For some it was a visit to the shore, the keeping of a marine aquarium, or, if lucky, while first snorkeling or scuba diving in a coral reef. Concern with our impact on the marine environment, particularly the conservation of marine life, is another motivation for taking a high school course in marine science.

Marine Science, adapted from the highly successful and respected *Marine Biology* text by Peter Castro Ph.D. and Michael Huber Ph.D., was especially written for the marine science courses that have become so popular in high schools from coast to coast. *Marine Science* is not a watered-down version of *Marine Biology* but is a rigorous and highly readable introduction to the oceans. Although it emphasizes marine life and its relationship with the ocean environment, the textbook has extensive material on the physical features of the world ocean. *Marine Science* was developed guided by the theme of how marine life interacts with its non-living environment and how the oceans and their inhabitants are being affected by human impact. The authors follow a global perspective to emphasize that the oceans are interconnected and that life on Earth is greatly affected by the world ocean.

Contents

The Authors

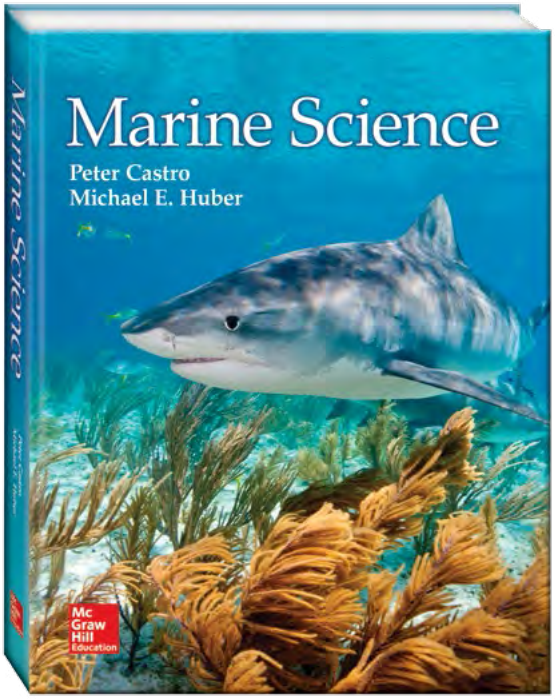
Peter Castro realized he had to become a marine biologist during a high school field trip to the coral reefs in his native Puerto Rico. He obtained a B.S. in biology from the University of Puerto Rico, Mayaguez, but left the warm Caribbean for warm Hawaii to obtain a Ph.D. in marine zoology from the University of Hawaii, Manoa. He is currently a professor at California State Polytechnic University, Pomona. He is fluent in five languages and taught marine biology as a Fulbright Scholar at Odessa State University in the former Soviet Union. His research specialty is the biology of crustaceans symbiotic with reef corals and other invertebrates, research that has taken him anywhere where the water is warm enough to dive. He has also been doing research for almost the last two decades on the systematics of deep-water crabs, mostly in Paris, France. Dr. Castro has published over 50 scientific papers on his research.

Peter Castro, Ph.D.

Michael became fascinated by aquatic organisms when he caught his first trout on an Alaskan lake at age two. His interest in marine biology grew, and he went on to obtain B.S. degrees in zoology and oceanography from the University of Washington in Seattle. He received his doctorate from Scripps Institution of Oceanography for research on a group of symbiotic coral crabs. He remained at Scripps as a research biologist, working on such diverse research topics as the genetics and cell biology of unicellular algae and bioluminescence in midwater organisms. Huber became increasingly involved in marine environmental science. This interest continued to grow when he became the Scientific Director of James Cook University's Orpheus Island Research Station on Australia's Great Barrier Reef. He became a full-time environmental advisor, providing scientific information and advice on marine environmental issues and the development of conservation programs to international agencies, governments and private industry. Dr. Huber is a member Emeritus of GESAMP, an international scientific body that advises the United Nations system on marine environmental issues.

Michael Huber, Ph.D.

Marine Science Table of Contents



Four Feature Strands

These include Nature of Science, Marine Science in Action, Habitat Spotlight, and Humans and the Ocean. Each explores a unique topic in marine science exploring habitats, human and ocean interaction, and other topics of interest. Each of these features has a corresponding inquiry activity available in Connect. These activities allow students to expand upon what they've studied in each feature.

NATURE OF SCIENCE

MARINE SCIENCE IN ACTION

HABITAT SPOTLIGHT

HUMANS AND THE OCEAN

Marine Science Guided Tour

Marine Science incorporates a variety of study aids to help students better understand the ocean and all its complexities.

Marine Fishes

Chapter 10

10.1 Fishes: the First Vertebrates
10.2 Fish Anatomy
10.3 Fish Adaptations

THEME Patterns

Marine fishes all share defining features of their shared ancestry, as well as unique adaptations for their particular environment.

BIG IDEA

Marine fishes are a diverse assemblage of species, with many adaptations to the marine environment.

About the photo A dusky grouper (*Epinephelus marginatus*), surrounded by smaller fish, in the Mediterranean Sea.

Purestock/SuperStock

10.1 *Fishes: the First Vertebrates* 265

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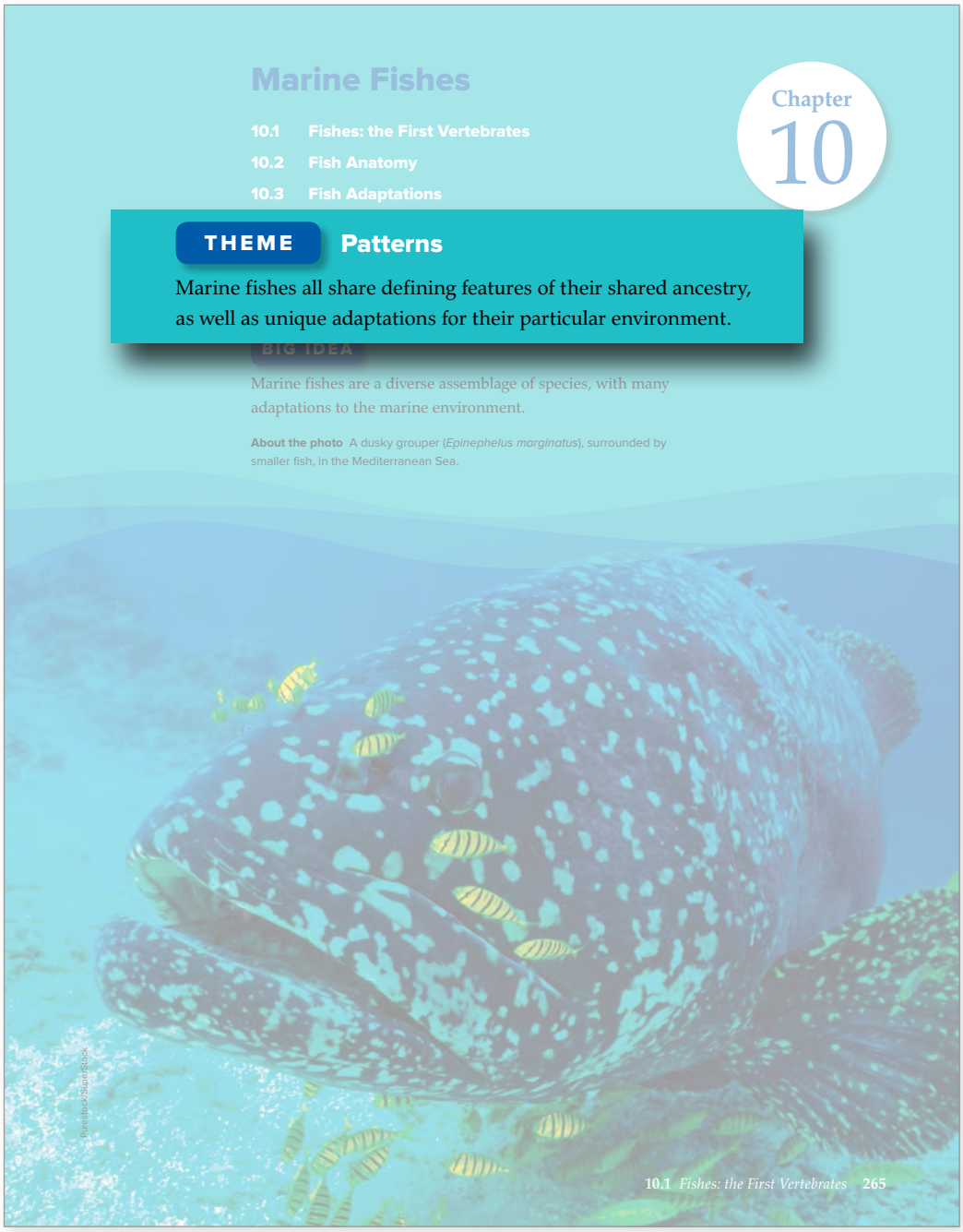

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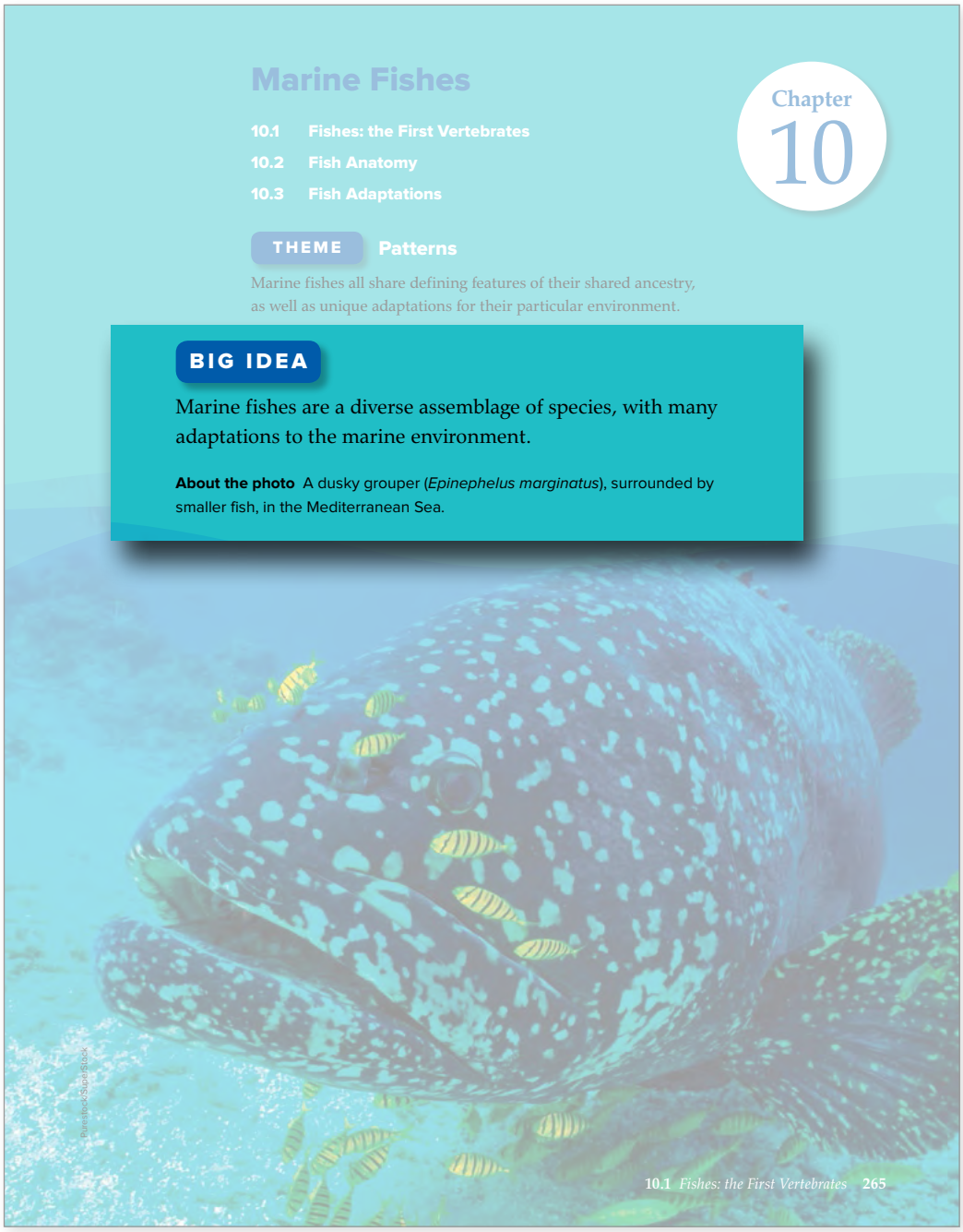

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The **Big Idea** is the main take away for the chapter. This Big Idea is what students should glean through their study of the chapter content.

Marine Science Guided Tour continued

Vocabulary indicates the important terms covered in the section.

VOCABULARY

- vertebrates
- vertebrae
- cartilage
- placoid scales
- caudal fin
- dorsal fins
- pectoral fins
- demersal
- cycloid
- ctenoid
- operculum
- fin rays
- swim bladder

.1 Fishes: the First Vertebrates

Main Idea

Scientists categorize fishes into three main groups based on body structure.

Key Questions

1. Which characteristics of fishes separate them from the rest of phylum Chordata?
2. What are the three traditional groups of fishes?

ebrates (subphylum Vertebrata) share four fundamental characteristics of phylum Chordata with protochordates, the invertebrate chordates like elets and sea squirts. Vertebrates differ from these other chordates in ng a backbone, also called the vertebral column or spine, which is a dorsal of hollow skeletal elements, usually bone, called **vertebrae**. The vertebrae ose and protect the nerve cord, also called the spinal cord, which ends in a brain that is protected by a skull made of cartilage or bone. Vertebrates also are characterized by a bilaterally symmetrical body and the presence of an internal skeleton, or endoskeleton.

Fishes are the oldest and structurally the simplest of all living vertebrates. They also are the most abundant vertebrates in terms of both species and individuals. About 32,000 species of fishes are presently known to science. They make up about half of all species of vertebrates on Earth. Most species of fishes, about 58%, are marine. Many new species are being discovered every year, but a good number is on the brink of extinction.

There is some disagreement as to how to classify the major groups of fishes. Three groups are traditionally recognized. One of the schemes proposed to show the relationships of these three groups with the rest of the vertebrates is given in Figure 10.1.

DIVE IN!

What characterizes vertebrates? Most chordates are vertebrates. While vertebrates are traditionally defined by possessing vertebrae, or a spine, this is not always the case. Hagfishes, which are a type of jawless fish, do not have true vertebrae. They do, however, share several morphological and molecular characteristics with vertebrates. Because of their genetic similarities to lampreys (another jawless fish that DO have vertebrae), most biologists have placed hagfishes in the subphylum Vertebrata.

Jawless Fishes

The most primitive fishes living today are the jawless fishes (Agnatha). Because they lack jaws, they feed by suction with the aid of a round, muscular mouth and rows of teeth. The body is cylindrical and elongated like that of eels or snakes (Fig. 10.2). They lack the paired fins and scales of most fishes, but, like fishes and other vertebrates, the brain is protected by a skull. Some biologists do not even consider jawless fishes to be vertebrates because they lack true vertebrae.

Hagfishes Hagfishes, or slime eels (*Myxine, Eptatretus*), are jawless fishes that feed mostly on dead or dying fishes (Fig. 10.2, p. 268). They are known as the slime eel because of the abundant mucus produced by glands on the skin. The mucus is used by hagfishes to protect themselves while feeding with their

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Marine Science Guided Tour continued

Vocabulary indicates the important terms covered in the section.

Each section opens with a **Main Idea** that summarizes the important points of the section.

The **Key Questions** are used to guide student reading and ensure that they understand the main idea of the chapter.

10.1 Fishes: the First Vertebrates

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Dive In! introduces students to the chapter content with an interesting and accessible example.

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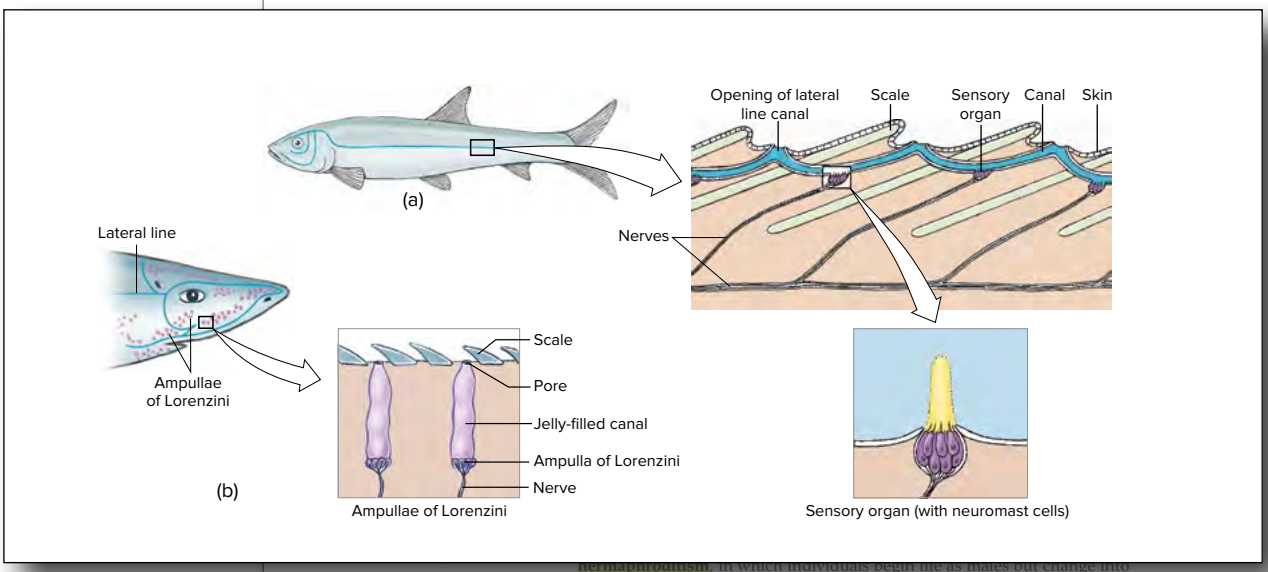

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IN CONTEXT

Hormones Molecules that act as chemical messengers within the body.

• 6.1, The Ingredients of Life

hermaphroditism, in which individuals begin life as males but change into females (protandry) or females change into males (protogyny). These changes are controlled by sex hormones but triggered by social cues such as the absence of a dominant male. Sex reversal occurs in several groups of marine fishes, but it is most prevalent among sea basses and groupers, parrotfishes, and wrasses. Some rather complicated reproductive strategies have been discovered among these fishes.

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Section Review

1. **Explain** How do marine fishes stay hydrated in such a salty external environment?
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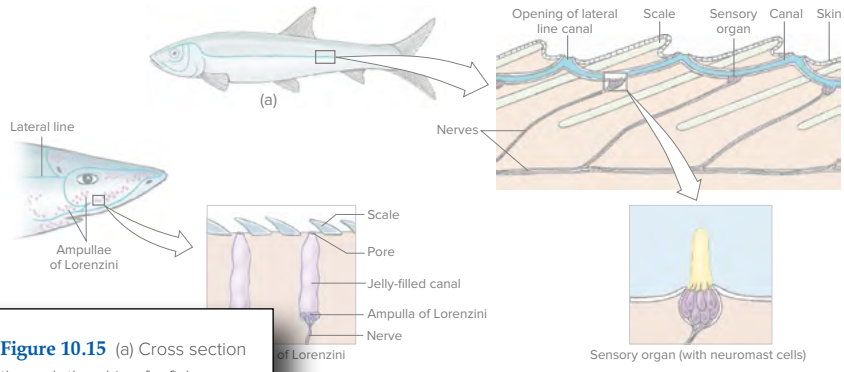

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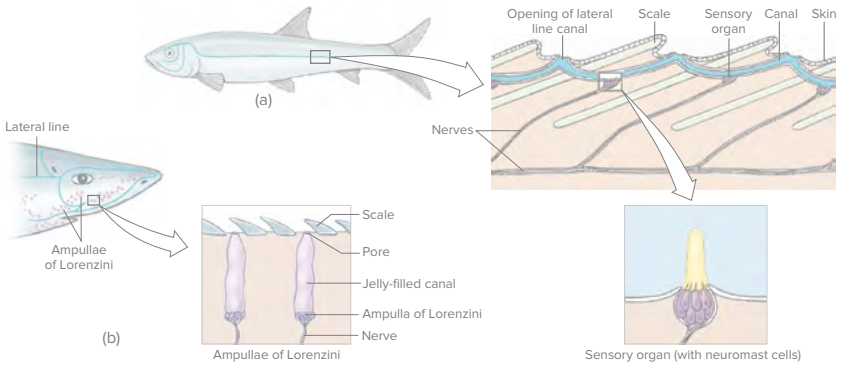

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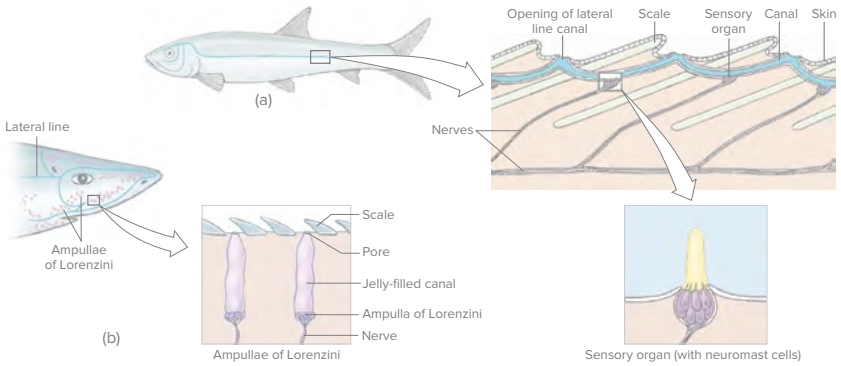

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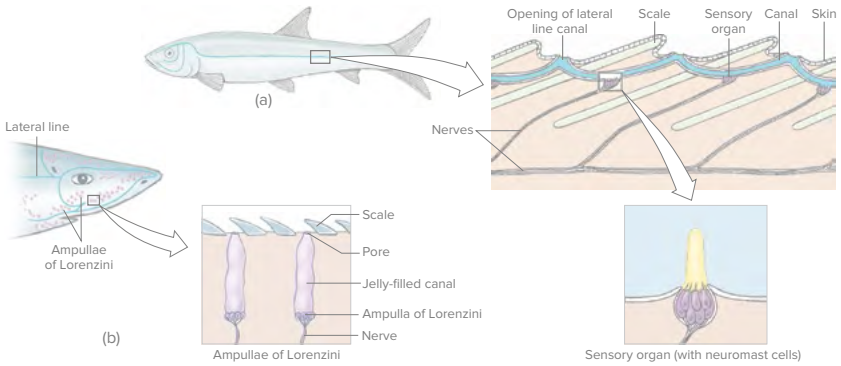

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Marine Science Guided Tour continued

The **Review Questions** are comprised of multiple choice, short answer, and critical thinking questions used to review the most important concepts addressed in the chapter.

Chapter 10 Review

REVIEW QUESTIONS

Multiple Choice

1. Which is not a characteristic of jawed fishes?

- **a.** endothermy
- **b.** gills
- **c.** skin covered by scales
- **d.** two-chambered heart

2. Cartilagenous fishes and bony fishes are different in that only

- **a.** bony fishes have paired fins.
- **b.** bony fishes have a keen sense of smell.
- **c.** bony fishes have an operculum.
- **d.** cartilaginous fishes have a complete skeleton.

3. Bony fishes are divided into which two groups?

- **a.** hagfishes and lampreys
- **b.** sharks and ray-finned fishes
- **c.** ray-finned fishes and lobe-finned fishes
- **d.** jawless fishes and cartilaginous fishes

Short Answer

4. What is the evolutionary significance of lobe-finned fishes?

5. Compare and contrast cartilaginous fishes and bony fishes.

6. Describe an adaptation of a marine fish for feeding on small prey like tiny crustaceans.

Critical Thinking

7. Hagfishes and lampreys are the only living representatives of a very ancient group. Why do you suppose there are still some of these jawless fishes around?

8. A deep-water shark, new to science, is collected for the first time. The specimen is studied in detail, but its stomach is empty. How can you get a rough idea of its feeding habits? The specimen is female, and its reproductive tract is found to contain 20 eggs. Can you tell the type of development characteristics of this species?

TA ANALYSIS LAB

an we learn more about basking sharks?

e scientists know very little about the lives of g sharks, including where they live, mate, and irth. In an effort to learn more, scientists tagged rks off the coast of Massachusetts.

and Observations

lustration shows the previously known ranges king sharks together with new information ed from the tags.

Critically

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ained from: Hamady, L. L., 2011. Clues in shark vertebrae reveal where en. Oceanus, vol. 49, no. 1, Winter, pp. 10–13.

Chapter 10 *Review* 301

Marine Science Guided Tour continued

The **Review Questions** are comprised of multiple choice, short answer, and critical thinking questions used to review the most important concepts addressed in the chapter.

Each chapter review includes a **Data Analysis Lab**. These labs use real-world current data and are directly related to the content covered in the chapter. Students must use the data provided to answer critical thinking questions. These labs are an excellent opportunity for students to develop their data analysis skills.

Chapter 10 Review

REVIEW QUESTIONS

Multiple Choice

1. Which is not a characteristic of jawed fishe
   - a. endothermy
   - b. gills
   - c. skin covered by scales
   - d. two-chambered heart
2. Cartilagenous fishes and bony fishes are d in that only
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   - b. bony fishes have a keen sense of smell.
   - c. bony fishes have an operculum.
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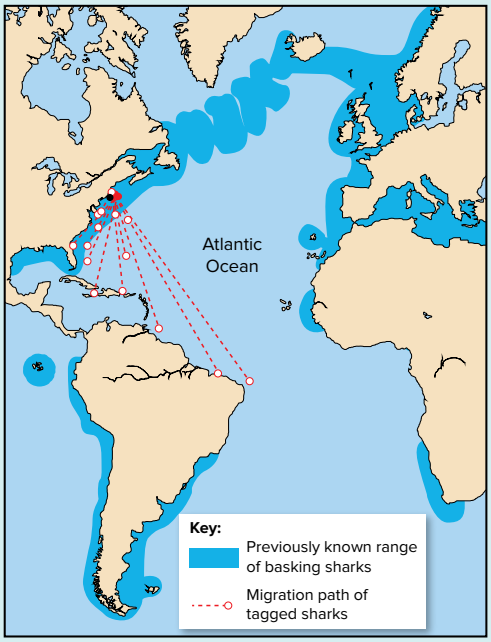
DATA ANALYSIS LAB

How can we learn more about basking sharks?
Marine scientists know very little about the lives of basking sharks, including where they live, mate, and give birth. In an effort to learn more, scientists tagged 18 sharks off the coast of Massachusetts.

Data and Observations

The illustration shows the previously known ranges of basking sharks together with new information retrieved from the tags.



Think Critically

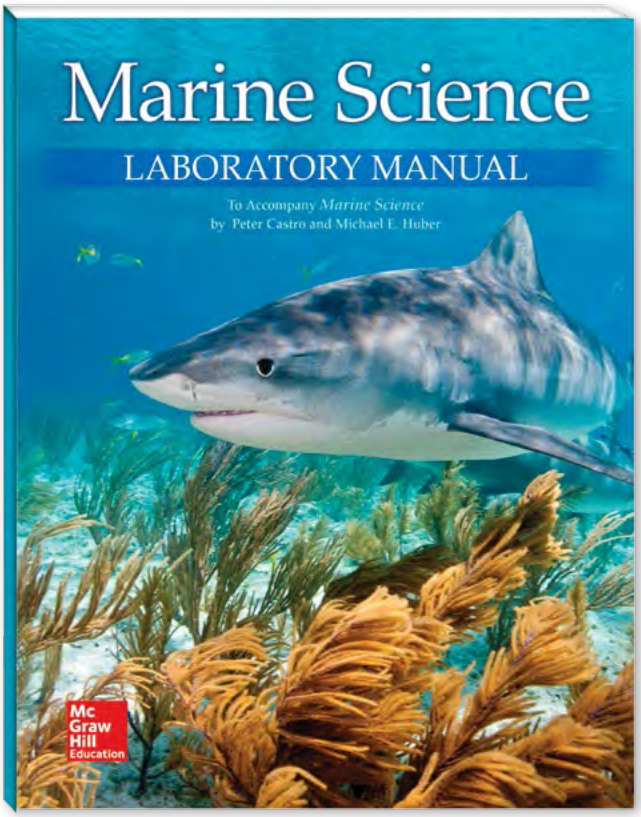
1. What did marine scientists learn from the data collected by the tags?
2. After analyzing the data from the tags in this study, the marine scientists hypothesized that the pregnant females and juveniles live in deep, tropical waters for months at a time. Describe a method in which this hypothesis could be tested.

**Data obtained from: Hamady, L. L., 2011. Clues in shark vertebrae reveal where they've been. Oceanus, vol. 49, no. 1, Winter, pp. 10–13.*

Marine Science Laboratory Manual

Our NEW *Marine Science Laboratory Manual* offers 34 new labs ideal for any marine science classroom. These labs can be performed anywhere in the country and do not require access to the ocean. Each lab is designed to be completed in one lab period. The *Marine Science Teacher's Manual* identifies the best time to use each lab in the course of your chapter instruction. The *Lab Manual Teacher's Guide* is located in **Connect**; it provides guidance for teachers on lab procedure as well as answers to the lab questions.

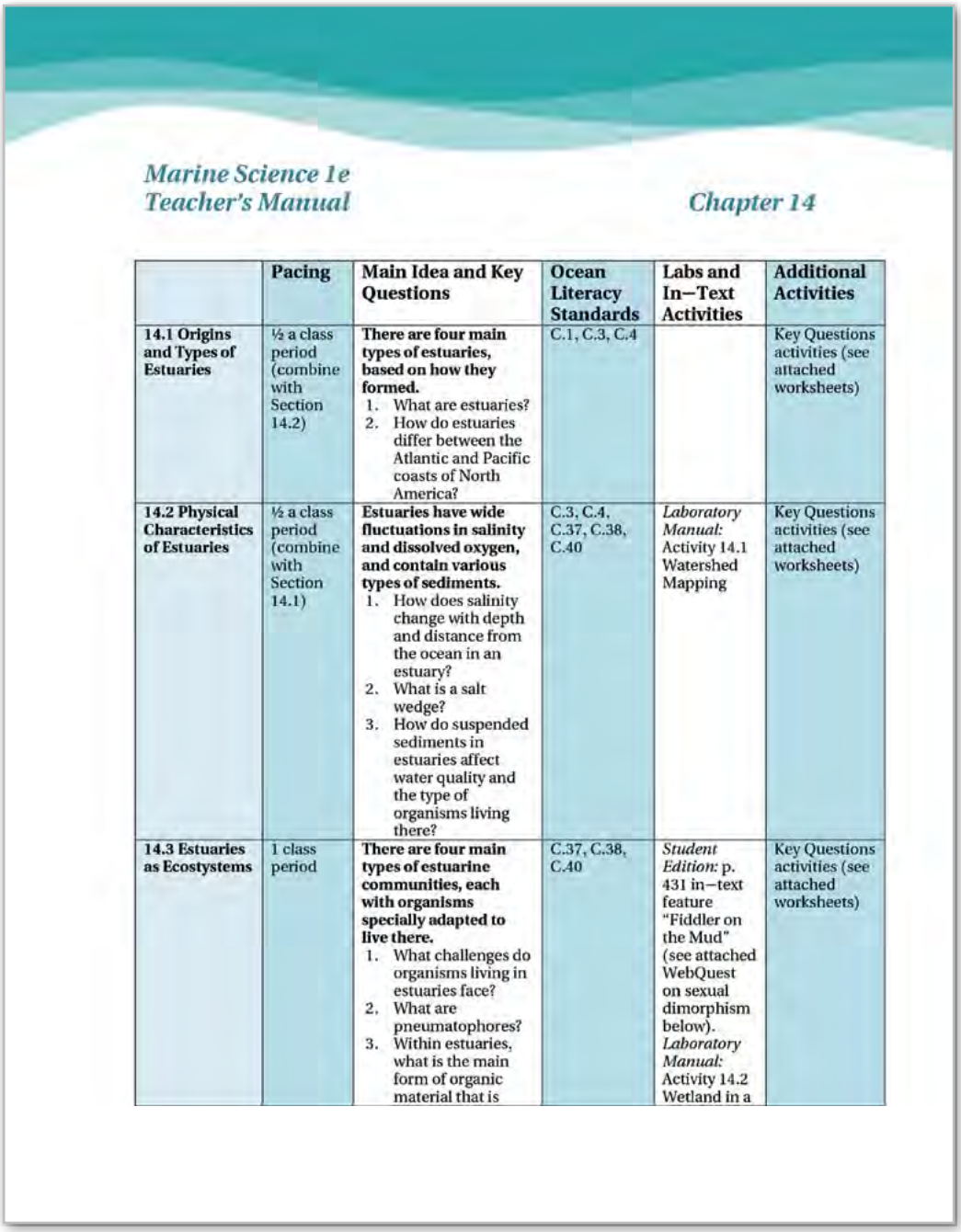
- **Material lists** are provided to help students and teachers prepare the lab and save time.
- Each lab begins with a **Problem** that sets up the purpose of the lab.
- **Objectives** help to focus students on what should be learned from the lab.
- A detailed **Procedure** is laid out for students to aid in their discovery.
- Questions and charts help students to demonstrate what they've learned from the lab.



Marine Science Teacher's Manual

Marine Science provides a robust teacher's manual. This teacher's manual, available through Connect, provides a detailed pacing guide for each chapter, Chapter Summaries, additional resources, answers to the Section and Chapter Review Questions, and many supplementary activities.

- The pacing guide indicates how many days you should designate for instruction for each section of the book.
- The **Main Idea** and **Key Questions** from the student edition are reviewed.
- Section content is correlated to the **Ocean Literacy Standards**.
- A suggested sequence for teaching Laboratory Manual and feature-based inquiry activities is provided.
- In addition, the teacher's manual also provides **Vocabulary** and **Key Question Activities** as well as **Chapter Projects**.



Marine Science 1e Teacher's Manual — *Chapter 14*

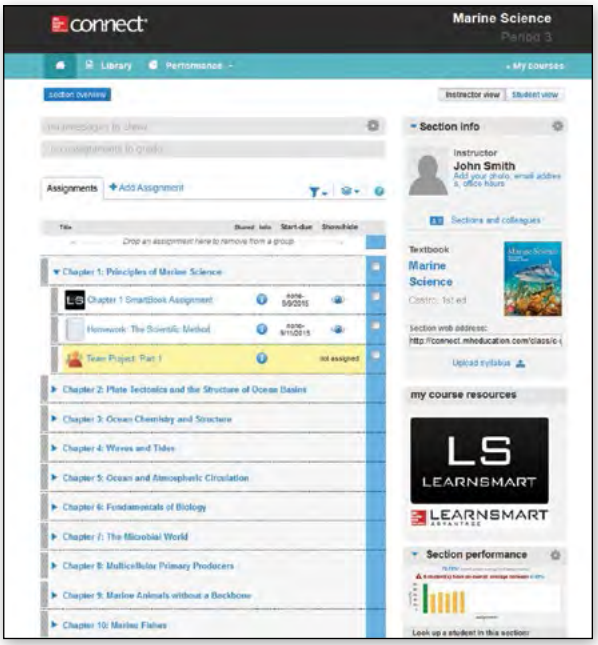
	Pacing	Main Idea and Key Questions	Ocean Literacy Standards	Labs and In–Text Activities	Additional Activities
14.1 Origins and Types of Estuaries	½ a class period (combine with Section 14.2)	**There are four main types of estuaries, based on how they formed.** 1. What are estuaries? 2. How do estuaries differ between the Atlantic and Pacific coasts of North America?	C.1, C.3, C.4		Key Questions activities (see attached worksheets)
14.2 Physical Characteristics of Estuaries	½ a class period (combine with Section 14.1)	**Estuaries have wide fluctuations in salinity and dissolved oxygen, and contain various types of sediments.** 1. How does salinity change with depth and distance from the ocean in an estuary? 2. What is a salt wedge? 3. How do suspended sediments in estuaries affect water quality and the type of organisms living there?	C.3, C.4, C.37, C.38, C.40	*Laboratory Manual:* Activity 14.1 Watershed Mapping	Key Questions activities (see attached worksheets)
14.3 Estuaries as Ecostystems	1 class period	**There are four main types of estuarine communities, each with organisms specially adapted to live there.** 1. What challenges do organisms living in estuaries face? 2. What are pneumatophores? 3. Within estuaries, what is the main form of organic material that is	C.37, C.38, C.40	*Student Edition:* p. 431 in–text feature "Fiddler on the Mud" (see attached WebQuest on sexual dimorphism below). *Laboratory Manual:* Activity 14.2 Wetland in a	Key Questions activities (see attached worksheets)

Digital Advantage

connect®

McGraw-Hill Connect® is a digital teaching and learning environment that saves time while improving student performance.

- Teachers have access to a variety of resources, including question banks, robust reporting, and a complete lab manual, lab manual teacher's guide, and teacher's manual.
- Auto-graded tests for each chapter are correlated to the Ocean Literacy Standards.
- The **Inquiry Activities** provided in Connect allow students to expand upon what they've studied in the **Nature of Science, Marine Science in Action, Habitat Spotlight,** and **Humans and the Ocean** features.
- Digital images and PowerPoint slides are available to help teachers build dynamic presentations.
- Tegrity Digital Lecture Capture enables teachers to record lectures and make them available to students anytime, anywhere, on just about any device.
- An adaptive **SmartBook®** ensures that students get the most out of each minute spent studying.



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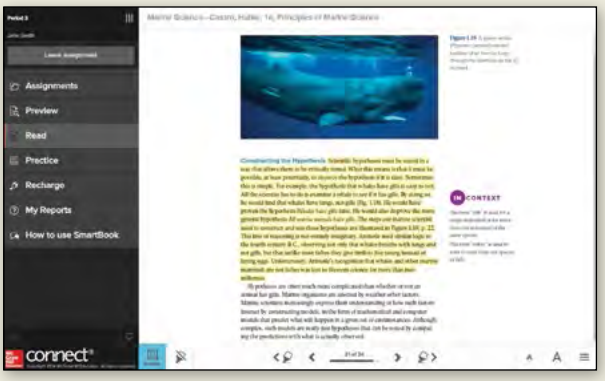
SmartBook® is the first and only adaptive reading experience designed to improve the way students read and learn. Powered by the intelligent diagnostic and adaptive LearnSmart® engine, SmartBook uses assessments that consider both confidence level and responses to content questions to identify what a student knows and doesn't know. As the student reads, the material constantly adapts to ensure the student is focused on the content he or she needs the most to close any knowledge gaps. The result is that students learn faster, study more efficiently, and retain more knowledge, allowing teachers to focus valuable class time on higher-level concepts.



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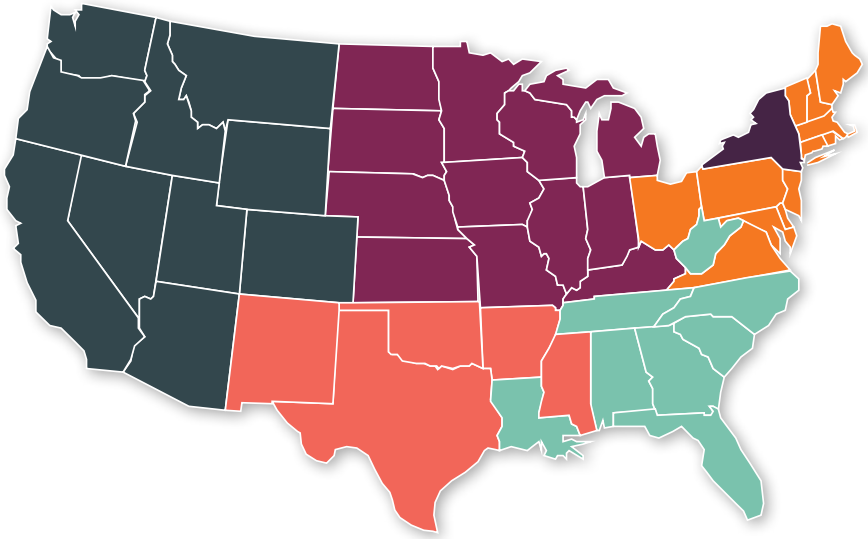

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- Program implementation training
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