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Correct Answers are located at the end of each chapter.

MULTIPLE CHOICE - Choose the one alternative that best completes the statement or answers the question.

1) The *Challenger* expedition made collections of marine organisms:
   A) Around the world.
   B) In the Pacific Ocean only.
   C) In the Atlantic Ocean only.
   D) In the Mediterranean Sea only.
   E) In the North Sea only.

2) The first marine laboratory in the world was established in:
   A) Russia.
   B) England.
   C) France.
   D) Italy.
   E) Japan.

3) The first marine laboratory established in the United States was:
   A) Friday Harbor Marine Laboratory in Washington.
   B) Scripps Institution of Oceanography in California.
   C) Marine Biological Laboratory at Woods Hole, Massachusetts.
   D) Smithsonian Institution in Washington.
   E) Hopkins Marine Station in California.

4) Charles Darwin, who proposed the theory of evolution by natural selection, was also a marine biologist who had a particular interest in:
   A) Whales.
   B) Fishes.
   C) Marine birds.
   D) Barnacles.
   E) Oysters.

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5) A technological development that was a direct development of World War II is:
   A) Scuba.
   B) Research vessels.
   C) Nets.
   D) Marine laboratories.
   E) Sonar.

6) The scientific method can be best described as:
   A) Undertaking of experiments in laboratories.
   B) Use of induction and deduction.
   C) Collecting data in the field.
   D) Procedures used to learn about our world.
   E) Steps used to obtain observations.

7) The factors that might affect observations and can be manipulated are called:
   A) Controls.
   B) Variables.
   C) Experiments.
   D) Hypotheses.
   E) Inductive observations.

8) A control can be best defined as:
   A) A variable that is kept constant in an experiment.
   B) An experiment where the final results are known ahead of time.
   C) A hypothesis that regulates the results of an experiment.
   D) An experiment that is undertaken both in the field and in the laboratory.
   E) A variable that changes during the course of an experiment.

9) A marine biologist observes that mako sharks, sardines, and salmon leap out of the water. An example of **induction** from these observations is:
   A) Only some fishes can leap out of the water.
   B) All fishes leap out of the water.
   C) Fishes leap out of the water to escape from predators.
   D) Flatfishes can leap out of the water since they live on the bottom.
   E) Leaping out of the water is often used in feeding.

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10) From the general statement "All fishes lay eggs," which of the following results from **deduction**?

A) Since tuna are fish, tuna lay eggs.
B) Since tuna are fish, tuna swim.
C) Egg laying is beneficial to fishes.
D) Tuna must lay their eggs in deep water.
E) Since fishes are marine, tuna lay eggs.

11) Which of these is an example of a hypothesis that is **not** a valid scientific hypothesis because it cannot be proven false?

A) The Earth is flat.
B) The sun revolves around the Earth.
C) Organisms similar to deep-water marine worms live in the center of the earth.
D) The deepest spot on the ocean is off the coast of a volcanic island.
E) Whales listen to sound.

12) An experiment can be best described as:

A) A set of observations that become a hypothesis.
B) Obtaining data from the field.
C) An artificially created situation to test a hypothesis.
D) Controlling a particular factor in the field.
E) Making observations from naturally occurring events.

13) A limiting factor of science is that it cannot:

A) Predict the future.
B) Make judgments about ethics, values, and morality.
C) Arrive at fundamental truths.
D) Provide information that can be applied to real life.
E) Provide exceptions for negative evidence.

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14) One of the following is outside the realm of science:
A) Observations made using extrasensory perception (ESP).
B) Data collected from an experiment.
C) Data collected from the field.
D) Anything that can be obtained by our senses.
E) Observations made by satellites.

15) Scientific knowledge is ultimately traced to:
A) Hypotheses.
B) Inductions.
C) Deductions.
D) Theories.
E) Observations.

16) When can a hypothesis be accepted as absolutely 100% true?
A) After one experiment or observation
B) After ten experiments or observations
C) After numerous experiments or observations over many years
D) Never

17) In experiments, scientists create artificial situations to test hypotheses because:
A) They cannot make the necessary observations under natural conditions.
B) It is always easier to study organisms in the lab.
C) Hypotheses cannot be accepted unless they have been studied under these conditions.
D) The scientific method requires it.

18) How much of the Earth's oxygen is generated by marine organisms?
A) 25%
B) 50%
C) 75%
D) 90%
E) 95%

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19) What is the estimated annual value of the ocean's living systems?
A) $ 2 million
B) $ 2 billion
C) $ 20 billion
D) $ 2 trillion
E) $20 trillion

20) Which of the following statements about Charles Darwin is not true?
A) Darwin proposed the theory of evolution by natural selection.
B) Darwin was the first to use a chronometer timepiece.
C) Darwin served as a naturalist on the *HMS Beagle*.
D) Darwin explained the formation of atolls.
E) Darwin used nets to capture plankton.

21) Who is the first scientist credited with documenting that seafloor life varies with depth?
A) Charles Darwin
B) James Cook
C) Leif Eriksson
D) Edward Forbes
E) Charles Wyville Thompson

22) Jacques Cousteau is best known for helping to perfect which marine technology?
A) Sonar
B) Remote sensing
C) Scuba diving equipment
D) Remotely operated vehicles (ROVs)
E) Autonomous underwater vehicles (AUVs)

23) The excellent book about the seashore life of the Pacific coast titled Between Pacific Tides was written by John Steinbeck, Jack Calvin and:_____
A) Jacques Cousteau.
B) Charles Darwin.
C) Edward Ricketts.
D) Louis Agassiz.

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Answer Key

Test name: CH-01

1) A
2) D
3) C
4) D
5) E
6) D
7) B
8) A
9) B
10) A
11) C
12) C
13) B
14) A
15) E
16) D
17) A
18) B
19) E
20) B
21) D
22) C
23) C

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CHAPTER 1
THE SCIENCE OF MARINE BIOLOGY

Chapter Outline

1.1. The Science of Marine Biology
- The History of Marine Biology
  - The *Challenger* Expedition
  - The Growth of Marine Labs
- Marine Biology Today
  - The Census of Marine Life

1.2. The Scientific Method
- Observation, the Currency of Science
- Two Ways of Thinking
  - Induction
  - Deduction
- Testing Ideas
  - Constructing the Hypothesis
  - The Nature of Scientific Proof
  - Testing the Hypothesis
  - The Scientific Theory
- Limitations of the Scientific Method

Box Readings:

1.1. *Eye on Science: The Best Laid Plans*

1.2. *Observing the Ocean*

1.3. *John Steinbeck and Ed Ricketts*

Chapter Summary

Chapter 1 introduces students to the scope and nature of marine biology and its relevance in the modern world. The first half of the chapter describes the science of marine biology by sketching its history and by describing the many roles marine biology plays in modern science and technology. The fact that the study of ocean life now involves specialists from many disciplines as well as a wide range of tools and techniques is highlighted. There is a box reading on the use of exciting new tools and technologies such as the "crittercams" that are attached to marine mammals to study their behavior. The box reading on Steinbeck and Ricketts puts a human face on marine biology.

The second half of the chapter emphasizes the scientific nature of modern marine biology by briefly discussing the nature of science and the scientific method, which is essential to understanding science. Key components, its application to the real world, and its limitations are outlined. This discussion of the material is essential to understanding science, especially among non-science majors.

The inclusion of the scientific method in a marine biology text is an innovative idea necessitated by the general education requirements that have been implemented by many institutions. The chapter, however, is written in a plain, unassuming style and profusely illustrated in order to make the concept of science less intimidating to non-science students. It can be assigned to be read independently at the start of the course. The main objective of this section is to introduce students to the meaning and significance of the *science* of marine biology.

The Eye on Science box on ocean observing systems should keep students interested throughout the course. They

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can follow current and future research using the links provided in the *Marine Biology*'s Online Learning Center.

Student Learning Outcomes

1. Demonstrate an understanding of the concept that marine biology is a science that applies biology to the sea.
2. Explain the highlights of the history of marine biology and some of the current developments in the field.
3. Demonstrate an understanding of the significance of the scientific method in learning about the natural world.
4. Explain how the scientific method is used to test hypotheses.
5. Compare and contrast between induction and deduction.

Answers to Critical Thinking Questions

1. Most of the major advances in marine biology have come in the last 200 years. What do you think are the reasons for this?

Reasons include increased mobility due to advances in the means of transportation (faster ships, planes), methodology (sampling equipment, microscopes, scuba, satellites, etc.), developments and discoveries in biology and other fields of science that have stimulated further research in the marine environment (theories of evolution, plate tectonics, etc.), and improved educational opportunities and facilities.

2. Recall that the statement "There are mermaids in the ocean" is not a valid scientific hypothesis. Can the same be said of the statement "There are no mermaids in the ocean"? Why?

Yes, it is a valid scientific hypothesis because it can be falsified if a mermaid is found. No scientific hypothesis can be proven so this does not mean it is not a scientific hypothesis. So far all attempts to falsify this hypothesis have failed: no one has found a mermaid. Thus, the hypothesis is accepted as true, though not proven.

3. Imagine that you are a marine biologist and you notice that a certain type of crab tends to be considerably larger in a local bay than the same type of crab that is in the waters outside the bay. What hypotheses might account for this difference? How would you go about testing these hypotheses?

Let students' imaginations roam free, even if they may not know the limitations and constrains of experimental work! It's a great way to stimulate their imagination and desire to learn. One possible hypothesis: "Crabs outside the bay are smaller because wave action outside the bay is stronger than inside the bay." We can reject it if some of these smaller crabs are moved inside the bay, placed in a cage that allows food to move in (as well as smaller crabs from inside the bay placed in identical cages), and all are checked and their size compared after a reasonable period of time. Remember a control experiment: crabs from outside and inside the bay placed in identical cages outside the bay. This hypothesis is rejected if size difference remains when all experimental populations are compared. Other possible hypotheses: differences due to food, predators, parasites, type of substrate, temperature, depth, etc. Students should be advised not to despair if they cannot come up with too many possible hypothesis—these factors will be discussed in successive chapters, particularly 10, 11, 12, and 13.

4. Many species of whale have been hunted to the brink of extinction. Many people think that we do not have the right to kill whales and that all whaling should cease. On the other hand, in many cultures whales have been hunted for centuries and still have great cultural importance. People from such cultures argue that limited whaling should be allowed to continue. What is the role that science can play in deciding who is right? What questions cannot be answered by science?

Science can provide evidence of the role whales play in the marine environment, factors related to the maintenance of biodiversity in our planet such as food for some predators (especially young whales), a place to live for some parasites and commensals, and potential control on the population size of their prey (additional information on the biology of whales is given in Chapter 9). Science, however, cannot provide answers concerning the value of the enjoyment people get by observing (or listening to) whales, as well as their importance in terms of food and source of various materials to some cultures. Science can help us decide, however, who benefits the most.

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