

## TABLE OF CONTENTS

<b>MODULE I .....</b>	<b>1</b>
<b>THE OCEANS OF OUR PLANET</b>	
The Geography of the Oceans.....	1
The Earth's Structure.....	3
Continental Drift and Plate Tectonics .....	4
Plate Interactions .....	8
Experiment 1.1: Mountain Formation from Plate Movement .....	9
Features of the Ocean Bottom.....	12
Properties of Water .....	14
Seawater .....	18
Experiment 1.2: Removing the Salt from Saltwater.....	19
Salinity, Temperature, and Density .....	21
Experiment 1.3: The Effects of Salinity and Temperature on the Density of Water .....	22
Light in the Sea .....	25
Pressure.....	26
The Motion of the Ocean .....	27
Experiment 1.4: The Coriolis Effect .....	28
Waves .....	32
Experiment 1.5: The Motion of Waves .....	32
Tides .....	33
Vertical Motion.....	35
Summing Up.....	36
Answers to the "On Your Own" Questions.....	37
Study Guide for Module 1 .....	39

**MODULE 2 .....** 41**LIFE IN THE SEA**

The Process of Life .....	41
Photosynthesis .....	43
Experiment 2.1: Photosynthesis .....	44
Respiration .....	46
Experiment 2.2: Respiration .....	46
Cells .....	48
Levels of Organization .....	51
The Challenge of Life in the Sea .....	52
Diffusion and Osmosis .....	53
Experiment 2.3: Osmosis .....	55
Temperature .....	58
Reproduction in the Sea .....	61
Asexual and Sexual Reproduction.....	61
Reproductive Strategies.....	63
Classifying Life in the Sea .....	64
Summing Up .....	66
Answers to the “On Your Own” Questions.....	67
Study Guide for Module 2 .....	69

**MODULE 3 .....** 71**THE FIRST FOUR KINGDOMS**

Kingdom Monera .....	72
Kingdom Protista: The Unicellular Algae.....	76
Diatoms .....	77
Dinoflagellates .....	79
Experiment 3.1: Unicellular Algae.....	81
Kingdom Protista: The Marine Protozoans .....	82
Foraminiferans .....	82
Radiolarians .....	84
Ciliates .....	84
Experiment 3.2: Marine Protozoans .....	85
Kingdom Protista: The Multicellular Algae .....	85
Green Algae .....	87
Brown Algae .....	88
Red Algae .....	89
Reproduction of Multicellular Algae.....	90
Kingdom Fungi .....	92
Kingdom Plantae.....	93
The Seagrasses .....	93
Saltwater Marsh Plants .....	94
The Mangroves.....	94
Summing Up .....	96
Answers to the “On Your Own” Questions.....	97
Study Guide for Module 3 .....	99

**MODULE 4 . . . . . 101****MARINE INVERTEBRATES I**

Phylum Porifera . . . . .	102
Experiment 4.1: Observation of a Sponge . . . . .	104
Phylum Cnidaria . . . . .	107
Class Hydrozoa . . . . .	111
Class Scyphozoa . . . . .	111
Class Anthozoa . . . . .	112
Phylum Ctenophora . . . . .	113
The Bilateral Worms . . . . .	114
Phylum Platyhelminthes . . . . .	114
Phylum Nemertea . . . . .	116
Experiment 4.2: One-Opening Gut Versus a True Digestive System . . . . .	117
Phylum Nematoda . . . . .	120
Phylum Annelida . . . . .	121
Class Polychaeta . . . . .	121
Lophophorates . . . . .	122
Summing Up . . . . .	124
Answers to the “On Your Own” Questions . . . . .	125
Study Guide for Module 4 . . . . .	127

**MODULE 5 . . . . . 129****MARINE INVERTEBRATES II**

Phylum Mollusca . . . . .	129
Class Gastropoda . . . . .	130
Class Bivalvia . . . . .	131
Class Cephalopoda . . . . .	133
Other Mollusk Classes . . . . .	135
Mollusk Biology . . . . .	136
Dissection Experiment 5.1: The Clam . . . . .	138
Phylum Arthropoda . . . . .	140
Class Crustacea . . . . .	141
Crustacean Biology . . . . .	144
Experiment 5.2: Crustacean Larvae . . . . .	145
Other Arthropod Classes . . . . .	146
Phylum Echinodermata . . . . .	147
Class Asteroidea . . . . .	149
Dissection Experiment 5.3: The Sea Star . . . . .	150
Class Ophiuroidea . . . . .	153
Class Echinoidea . . . . .	153
Class Holothuroidea . . . . .	153
Class Crinoidea . . . . .	154
Echinoderm Biology . . . . .	154
Phylum Chordata . . . . .	156
Subphylum Urochordata . . . . .	157

Subphylum Cephalochordata .....	158
Summing Up .....	160
Answers to the “On Your Own” Questions.....	161
Study Guide for Module 5 .....	163
<b>MODULE 6 .....</b>	<b>167</b>
<b>MARINE VERTEBRATES I</b>	
Class Agnatha .....	168
Class Chondrichthyes .....	169
Rays and Skates .....	173
The Bony Fishes .....	175
Experiment 6.1: Types of Fish Scales.....	176
The Biology of Fishes .....	178
Coloration in Fishes .....	180
Locomotion .....	182
Feeding and Digestion.....	182
The Circulatory System.....	184
The Gills and Respiratory System .....	185
Osmoregulation and Osmosis.....	187
The Nervous System in the Fishes .....	187
Dissection Experiment 6.2: The Shark.....	189
Social Behavior .....	193
Migrations .....	194
Reproduction in the Fishes .....	195
Summing Up .....	198
Answers to the “On Your Own” Questions.....	199
Study Guide for Module 6 .....	201
<b>MODULE 7 .....</b>	<b>205</b>
<b>MARINE VERTEBRATES II</b>	
Class Reptilia .....	205
Class Aves .....	211
Gulls and Similar Birds .....	212
Penguins .....	212
Shearwaters and Similar Birds.....	213
Pelicans and Similar Birds .....	214
Birds at the Shore .....	216
Class Mammalia .....	216
Order Cetacea.....	217
Order Sirenia .....	221
Order Pinnipedia.....	221
Order Carnivora .....	222
Echolocation.....	223
Experiment 7.1: Dolphin Echolocation.....	225
Movement in the Water.....	227

Experiment 7.2: What Causes the Bends? . . . . .	228
Behavior . . . . .	229
Mating and Reproduction. . . . .	232
Summing Up . . . . .	233
Answers to the “On Your Own” Questions. . . . .	234
Study Guide for Module 7 . . . . .	236
<b>MODULE 8 . . . . .</b>	<b>239</b>
<b>MARINE ECOLOGY</b>	
The Ecosystem . . . . .	239
Population Growth . . . . .	241
Predator and Prey Relationships . . . . .	244
Symbiosis . . . . .	246
Trophic Relationships . . . . .	249
Primary Productivity. . . . .	252
Experiment 8.1: Exploring Carbon Fixation . . . . .	253
The Carbon and Nitrogen Cycles . . . . .	257
Environmental Zones . . . . .	260
Summing Up . . . . .	261
Answers to the “On Your Own” Questions. . . . .	262
Study Guide for Module 8 . . . . .	264
<b>MODULE 9 . . . . .</b>	<b>267</b>
<b>THE INTERTIDAL ZONE</b>	
Intertidal Communities . . . . .	268
The Rocky Intertidal . . . . .	268
Rocky Intertidal Abiotic Conditions . . . . .	269
Intertidal Feeding and Reproduction. . . . .	272
Wave Action . . . . .	273
Surviving the Waves . . . . .	275
Zonation of the Rocky Intertidal . . . . .	276
The Upper Intertidal Zone . . . . .	278
The Middle Intertidal Zone. . . . .	279
The Lower Intertidal Zone . . . . .	282
The Sandy and Muddy Intertidal . . . . .	283
Experiment 9.1: Exploring Intertidal Sediments . . . . .	286
Experiment 9.2: The Movement of Water Through Sediment . . . . .	287
Survival in the Mud . . . . .	288
Summing Up . . . . .	291
Answers to the “On Your Own” Questions. . . . .	292
Study Guide for Module 9 . . . . .	294

**MODULE 10 . . . . . 297****ESTUARY COMMUNITIES**

The Ice Age: The Most Likely Cause of Most Estuaries . . . . .	298
Types of Estuaries . . . . .	301
Abiotic Factors in Estuaries . . . . .	304
Estuarine Communities . . . . .	308
Estuarine Habitats . . . . .	310
Wetlands . . . . .	311
Experiment 10.1: Distribution of Mangroves in an Estuary . . . . .	313
Mudflats . . . . .	315
Channels . . . . .	318
Estuary Production . . . . .	318
Summing Up . . . . .	319
Answers to the “On Your Own” Questions . . . . .	320
Study Guide for Module 10 . . . . .	322

**MODULE 11 . . . . . 325****CORAL REEFS**

Coral Reef Requirements and Locations . . . . .	325
Reef Composition . . . . .	327
Coral Reef Formation and Growth . . . . .	329
Experiment 11.1: Examining Coral . . . . .	334
Types of Reefs . . . . .	336
Coral Reef Ecology . . . . .	344
Reef Relationships . . . . .	345
Symbiotic Relationships . . . . .	347
Summing Up . . . . .	349
Answers to the “On Your Own” Questions . . . . .	350
Study Guide for Module 11 . . . . .	352

**MODULE 12 . . . . . 355****CONTINENTAL SHELF COMMUNITIES**

Physical Features of the Continental Shelf . . . . .	355
Soft-Bottom Shelf Communities . . . . .	357
Unvegetated Soft Bottom Environments . . . . .	358
Experiment 12.1: Meiofaunal Organisms . . . . .	360
Vegetated Soft-Bottom Environments . . . . .	364
Hard-Bottom Shelf Communities . . . . .	367
Kelp Beds and Forests . . . . .	369
Sea Urchins . . . . .	374
Summing Up . . . . .	375
Answers to the “On Your Own” Questions . . . . .	376
Study Guide for Module 12 . . . . .	378

<b>MODULE 13 . . . . .</b>	<b>381</b>
<b>THE EPIPELAGIC ZONE</b>	
The Epipelagic Zone . . . . .	381
Life in the Epipelagic . . . . .	383
Epipelagic Phytoplankton . . . . .	384
Epipelagic Zooplankton . . . . .	386
Experiment 13.1: Observing Live Microplankton . . . . .	387
Epipelagic Nekton . . . . .	391
Staying Afloat in the Epipelagic . . . . .	393
Experiment 13.2: Water Drag . . . . .	393
Living in the Epipelagic Zone . . . . .	397
Vertical Migration . . . . .	399
The Epipelagic Food Web . . . . .	399
Primary Productivity . . . . .	402
Nutrients and Productivity . . . . .	403
El Niño-Southern Oscillation . . . . .	406
Summing Up . . . . .	408
Answers to the “On Your Own” Questions . . . . .	409
Study Guide for Module 13 . . . . .	411
<b>MODULE 14 . . . . .</b>	<b>413</b>
<b>THE DEEP OCEAN</b>	
The Mesopelagic . . . . .	414
Mesopelagic Food Webs . . . . .	417
Mesopelagic Body Design . . . . .	419
Experiment 14.1: Chemical “Bioluminescence” . . . . .	422
Experiment 14.2: The Bioluminescence of Plankton . . . . .	424
The Deep Sea . . . . .	425
The Deep-Sea Floor . . . . .	428
Hydrothermal Vents . . . . .	430
Other Vent Communities . . . . .	433
Deep-Sea Photosynthesis . . . . .	434
Summing Up . . . . .	435
Answers to the “On Your Own” Questions . . . . .	436
Study Guide for Module 14 . . . . .	438

<b>MODULE 15 . . . . .</b>	<b>441</b>
<b>OCEAN RESOURCES</b>	
Food from the Sea . . . . .	441
Food Species and Their Locations . . . . .	442
“Experiment” 15.1: Mapping Ocean Resources . . . . .	443
Managing Populations . . . . .	449
Mariculture . . . . .	453
Other Living Resources . . . . .	456
Nonliving Ocean Resources . . . . .	457
Summing Up . . . . .	461
Answers to the “On Your Own” Questions . . . . .	462
Study Guide for Module 15 . . . . .	463
<b>MODULE 16 . . . . .</b>	<b>465</b>
<b>EFFECTS OF HUMANS ON THE SEA</b>	
Ocean Habitat Damage . . . . .	466
Effects on Coral Reefs . . . . .	466
Pollution . . . . .	467
Sewage . . . . .	468
Fertilizers . . . . .	469
Oil . . . . .	470
Synthetic Pollutants . . . . .	472
DDT . . . . .	473
Experiment 16.1: Biomagnification . . . . .	474
Other Toxic Chemicals . . . . .	477
Metals and Other Toxic Materials . . . . .	478
Trash and Other Debris . . . . .	479
Our Responsibility . . . . .	479
In Summary . . . . .	481
Answers to the “On Your Own” Questions . . . . .	482
Study Guide for Module 16 . . . . .	483
<b>GLOSSARY . . . . .</b>	<b>485</b>
<b>APPENDICES . . . . .</b>	<b>495</b>
Appendix A: Reference Figures and Tables . . . . .	495
Appendix B: Module Summaries . . . . .	505
Appendix C: Complete List of Lab Supplies . . . . .	541
<b>INDEX . . . . .</b>	<b>XX</b>