

Contents

STUDENT EDITION

FIGURES AND TABLES IN THE <i>STUDENT EDITION</i>	viii
PREFACE	ix
SciLinks	xi

SECTION 1. UNDERSTANDING BIODEGRADATION

CHAPTER 1. NATURAL FORCES OF DECAY AND RENEWAL	3
Biodegradation	3
Producers and Consumers	4
Nutrient Cycles and Energy Flows	6
Classification of Living Things	9
Biodegradation on Land	10
Biodegradation in Water	12
<i>Organic Pollution</i>	12
<i>Eutrophication</i>	14
Conclusion	14
Discussion Questions	15
CHAPTER 2. HARNESSING NATURAL DECAY	17
Human Waste Disposal Processes	17
Biodegradable Plastics	18
Landfills	18
Composting	20
<i>Compost Biology</i>	21
<i>Compost Chemistry and Physics</i>	22
Wastewater Treatment	24
<i>Using Wetlands to Purify Wastewater</i>	27
Discussion Questions	27
CHAPTER 3. BIOREMEDIATION: USING MICROBES TO CLEAN UP	
CONTAMINATED SITES	29
Degrading Groundwater Contaminants	30
Cleaning Up Oil Spills	32
Choosing When to Use Bioremediation	34
Discussion Questions	34

SECTION 2. BIODEGRADATION PROTOCOLS: INTRODUCTION TO RESEARCH

IDENTIFYING DECOMPOSERS	37
Protocol 1. Picking and Sorting Invertebrates	37
Protocol 2. Berlese Funnel for Collecting Invertebrates	42
Protocol 3. Wet Extraction of Soil Organisms	44
Protocol 4. Collecting and Observing Aquatic Invertebrates	46
Protocol 5. Observing Soil Microorganisms	53
Protocol 6. Culturing Bacteria	55
Protocol 7. Culturing Fungi	59
CHEMICAL EFFECTS OF BIODEGRADATION	62
Protocol 8. Measuring CO ₂ Produced in Soil or Compost	62
Protocol 9. Measuring Dissolved Carbon Dioxide	77
Protocol 10. Measuring Dissolved Oxygen	79
Protocol 11. Measuring Biochemical Oxygen Demand (BOD)	83
COMPOSTING AND LANDFILLING	87
Protocol 12. Using Soda Bottle Bioreactors for Biodegradation Experiments	87
BIOREMEDIATION	91
Protocol 13. Growing Enrichment Cultures	91
Protocol 14. Isolating the Degraders	93
PROTOCOL PLANNING AND REVIEW FORMS	95
Protocol Planning Form	96
Data Analysis Peer Review Form	97

SECTION 3. INTERACTIVE RESEARCH: EXPERIMENTS AND FIELD STUDIES

IDEAS FOR BIODEGRADATION RESEARCH	101
Invertebrate Life	101
<i>Compost Invertebrates</i>	101
<i>Soil Invertebrates</i>	101
<i>Aquatic Invertebrates</i>	102
Microbial Life	102
Chemical Effects of Biodegradation	103
<i>Oxygen and Carbon Dioxide</i>	103
<i>pH</i>	103
Composting	104
<i>Bioreactor Design</i>	104
<i>Compost Ingredients</i>	104
<i>Microorganisms</i>	104

<i>Compost Physics</i>	105
<i>Effects of Compost on Plant Growth</i>	105
Biodegradation in Landfills	105
<i>Biodegradable Plastics</i>	106
Bioremediation	106
<i>Cleaning Up an Oil Spill</i>	106
<i>Isolating the Degraders</i>	107
<i>Comparing with Other Microbes</i>	107
FORMS FOR INTERACTIVE RESEARCH	109
Planning Research	110
Choosing a Research Topic	110
Interactive Research Planning Form #1	113
Interactive Research Planning Form #2	115
Presenting Research Results	120
Research Report Form	120
Poster Guidelines	123
Peer Review Forms	124
Experimental Design Peer Review Form	124
Research Report Peer Review Form	125
Poster Peer Review Form	126

SECTION 4. INTERACTIVE RESEARCH: WASTEWATER TREATMENT DESIGN CHALLENGE

WASTEWATER TREATMENT DESIGN CHALLENGE	129
Materials	129
Setting the Scene	129
The Challenge	130
Design Criteria and Constraints	131
The Design Process	132
FORMS FOR WASTEWATER TREATMENT DESIGN CHALLENGE	135
Parts List and Cost Analysis Form	136
Design Selection Rubric	137
Design Proposal Form	138
Design Challenge Peer Review Form	140