

# *Exploring Creation With Biology*

## Table of Contents

<b>MODULE #1: Biology: The Study of Life</b> .....	<b>1</b>
Introduction .....	1
What Is Life? .....	1
DNA and Life .....	1
Energy Conversion and Life .....	2
Sensing and Responding to Change .....	6
All Life Forms Reproduce .....	7
Life’s Secret Ingredient .....	8
The Scientific Method .....	9
Limitations of the Scientific Method .....	12
Spontaneous Generation: The Faithful Still Cling to It! .....	15
Biological Classification .....	16
Characteristics Used to Separate Organisms into Kingdoms .....	18
The Definition of Species .....	20
Biological Keys .....	21
Experiment 1.1: Using a Biological Key .....	24
Naming Organisms Based on Classification .....	27
Alternate Forms of Taxonomy .....	27
The Microscope .....	30
Experiment 1.2: Introduction to the Microscope .....	30
<b>MODULE #2: Kingdom Monera</b> .....	<b>37</b>
Introduction .....	37
Bacteria .....	37
The Eating Habits of Bacteria .....	41
Asexual Reproduction in Bacteria .....	44
Genetic Recombination in Bacteria .....	47
Transformation and Transduction .....	49
Endospore Formation .....	50
Bacterial Colonies .....	50
Experiment 2.1: Pond Life, Part A .....	52
Classification in Kingdom Monera .....	53
Classes in Kingdom Monera .....	54
A Few Words on Other Classification Systems .....	56
Specific Bacteria .....	56
Conditions for Bacterial Growth .....	58
Preventing Bacterial Infections .....	59
Take a Look at the Microscopic World .....	60
Experiment 2.2: Pond Life, Part B .....	60

**MODULE #3: Kingdom Protista ..... 67**

Introduction .....	67
Experiment 3.1: Pond Life, Part C .....	67
Classification in Kingdom Protista .....	68
Subkingdom Protozoa .....	71
Phylum Sarcodina.....	71
Other Sarcodines .....	73
Phylum Mastigophora .....	74
Other Mastigophorites.....	75
Phylum Ciliophora .....	78
Other Members of Phylum Ciliophora.....	79
Phylum Sporozoa .....	80
Experiment 3.2: Subkingdom Protozoa.....	82
Subkingdom Algae .....	84
Phylum Chlorophyta.....	85
Phylum Chrysophyta .....	87
Phylum Pyrrophyta.....	88
Phylum Phaeophyta.....	89
Phylum Rhodophyta .....	91
Experiment 3.3: Subkingdom Algae .....	91
Summing Up Kingdom Protista .....	92

**MODULE #4: Kingdom Fungi..... 97**

Introduction .....	97
General Characteristics of Fungi.....	97
Reproduction in Kingdom Fungi.....	101
Classification in Kingdom Fungi .....	102
Phylum Basidiomycota.....	103
Other Members of Phylum Basidiomycota .....	106
Experiment 4.1: Phylum Basidiomycota.....	107
Phylum Ascomycota.....	109
Yeasts .....	109
Experiment 4.2: Yeast and the Fermentation Process.....	110
Other Members of Phylum Ascomycota .....	111
Phylum Zygomycota .....	112
Experiment 4.3: Molds .....	114
Phylum Chytridiomycota .....	115
Phylum Deuteromycota: The Imperfect Fungi.....	115
Optional Experiment 4.4: Imperfect Fungi .....	116
Phylum Myxomycota .....	117
Symbiosis in Kingdom Fungi.....	119
Summing Up Kingdom Fungi .....	120

**MODULE #5: The Chemistry of Life ..... 125**

Introduction .....	125
Atoms: The Basic Building Blocks of Matter .....	125
Elements .....	128
Molecules .....	130
Changes in Matter .....	132
Physical Change .....	133
Experiment 5.1: Diffusion .....	134
Experiment 5.2: Osmosis .....	135
Chemical Change .....	139
Photosynthesis .....	140
Organic Chemistry .....	142
Carbohydrates .....	142
Organic Acids and Bases .....	146
Lipids .....	148
Proteins and Enzymes .....	149
Experiment 5.3: The Fragility of an Enzyme .....	152
DNA .....	154

**MODULE #6: The Cell ..... 161**

Introduction .....	161
Cellular Functions .....	161
Cell Structure .....	164
The Cell Wall .....	165
The Plasma Membrane .....	165
The Cytoplasm .....	166
The Mitochondrion .....	167
The Lysosome .....	167
Ribosomes .....	168
The Endoplasmic Reticulum .....	168
The Plastids .....	168
Vacuoles and Vesicles .....	169
Golgi Bodies .....	171
Centrioles .....	172
The Nucleus .....	172
The Cytoskeleton .....	173
As If This Isn't Already Complicated Enough! .....	174
Experiment 6.1: Cell Structure I .....	175
How Substances Travel In and Out of Cells .....	176
Experiment 6.2: Cell Structure II .....	181
How Cells Get Their Energy .....	182
ATP and ADP .....	186

**MODULE #7: Cellular Reproduction and DNA ..... 195**

Introduction ..... 195  
Genes, Chromosomes, and DNA ..... 195  
Experiment 7.1: DNA Extraction ..... 197  
Protein Synthesis – Part 1: Transcription ..... 198  
Protein Synthesis – Part 2: Translation ..... 201  
Mitosis: Eukaryotic Asexual Reproduction ..... 205  
Experiment 7.2: Mitosis ..... 210  
Diploid and Haploid Cells ..... 211  
Meiosis: The Cellular Basis of Sexual Reproduction ..... 213  
Viruses ..... 218

**MODULE #8: Mendelian Genetics ..... 227**

Introduction ..... 227  
Gregor Mendel ..... 227  
Mendel’s Experiments ..... 228  
Updating the Terminology ..... 233  
Punnett Squares ..... 236  
Pedigrees ..... 238  
Experiment 8.1: Making Your Own Earlobe Pedigree ..... 241  
More Complex Crosses ..... 242  
“Experiment” 8.2: A Dihybrid Cross ..... 246  
Sex and Sex-Linked Genetic Traits ..... 247  
“Experiment” 8.3: Sex-Linked Genetic Traits ..... 249  
A More Complete Understanding of Genetics ..... 250  
Genetic Disorders and Diseases ..... 252  
Summing Up ..... 255  
Experiment 8.4: Environmental Factors and Their Effect on Radish Leaf Color ..... 255

**MODULE #9: Evolution: Part Scientific Theory, Part Unconfirmed Hypothesis ..... 261**

Introduction ..... 261  
Charles Darwin ..... 262  
Darwin’s Theory ..... 264  
Microevolution and Macroevolution ..... 267  
Inconclusive Evidence: The Geological Column ..... 270  
The Details of the Fossil Record: Evidence Against Macroevolution ..... 273  
The Cambrian Explosion ..... 280  
Structural Homology: Formerly Evidence for Macroevolution, Now Evidence against It ..... 282  
Molecular Biology: The Nail in Macroevolution’s Coffin ..... 285  
Macroevolution Today ..... 289  
Why Do So Many Scientists Believe in Macroevolution? ..... 293

<b>MODULE #10: Ecology .....</b>	<b>299</b>
Introduction .....	299
Energy and Ecosystems.....	301
Mutualism.....	305
The Physical Environment .....	309
The Water Cycle.....	311
The Oxygen Cycle.....	314
The Carbon Cycle.....	316
Experiment 10.1: Carbon Dioxide and the Greenhouse Effect.....	317
The Nitrogen Cycle .....	322
Summing Up.....	324
<b>MODULE #11: The Invertebrates of Kingdom Animalia .....</b>	<b>329</b>
Introduction .....	329
Symmetry .....	329
Phylum Porifera: The Sponges.....	332
Experiment 11.1: Observation of the Spicules of a Sponge.....	334
Phylum Cnidaria.....	335
Specific Members of Phylum Cnidaria .....	337
Experiment 11.2: Observation of a Hydra .....	339
Phylum Annelida.....	342
Feeding Habits of the Earthworm .....	343
The Respiratory and Circulatory Systems in an Earthworm.....	344
The Earthworm’s Reproductive System.....	345
Other Segmented Worms .....	346
Experiment 11.3: Earthworm Dissection .....	347
Phylum Platyhelminthes: The Planarian .....	350
Experiment 11.3: Observation of a Planarian .....	351
Other Members of Phylum Platyhelminthes .....	352
Phylum Nematoda .....	352
Phylum Mollusca.....	354
Summing Up the Invertebrates.....	356
<b>MODULE #12: Phylum Arthropoda .....</b>	<b>361</b>
Introduction .....	361
General Characteristics of Arthropods.....	361
Class Crustacea: The Crayfish .....	365
The Crayfish’s Respiratory System.....	366
The Crayfish’s Circulatory System .....	368
The Crayfish’s Digestive System.....	370
The Crayfish’s Nervous System.....	370
The Crayfish’s Reproductive System.....	371
Other Crustaceans .....	371
Experiment 12.1: Crayfish Dissection .....	373
Class Arachnida.....	376

The Spider .....	377
The Major Points of Interest in Spider Anatomy .....	378
Classes Chilopoda and Diplopoda.....	380
Class Insecta.....	381
The Basic Anatomy of an Insect .....	382
Respiration and Circulation in Insects .....	382
The Feeding Habits of Insects.....	383
Reproduction and Development in Insects.....	383
A Few Orders in Class Insecta .....	385
Experiment 12.2: Insect Classification.....	389

**MODULE #13: Phylum Chordata ..... 393**

Introduction .....	393
Subphylum Urochordata.....	394
Subphylum Cephalochordata .....	395
Subphylum Vertebrata.....	396
The Endoskeleton.....	396
The Circulatory System.....	399
The Nervous System .....	399
Reproduction .....	401
Class Agnatha.....	403
Class Chondrichthyes.....	404
Class Osteichthyes.....	409
The Diversity of Class Osteichthyes .....	414
Experiment 13.1: Perch Dissection .....	416
Class Amphibia .....	419
Specific Creatures in Class Amphibia.....	421
Experiment 13.2: Frog Dissection.....	422
Alternate Experiment For Module #13: Field Study II .....	422
Summing Up.....	423

**MODULE #14: Kingdom Plantae: Anatomy and Classification ..... 429**

Introduction .....	429
Basic Plant Anatomy .....	429
The Macroscopic Structure of a Leaf.....	431
Experiment 14.1: Leaf Collection and Identification.....	435
The Microscopic Structure of a Leaf.....	436
Leaf Color.....	438
Experiment 14.2: How Anthocyanins and pH Help Determine Leaf Color .....	439
Roots.....	442
Stems .....	446
Experiment 14.3: Cross Sections of Roots, Stems, and a Leaf .....	449
Classification of Plants.....	452
The Bryophytes .....	452
Seedless Vascular Plants .....	455
Seed-Making Plants.....	457

<b>MODULE #15: Kingdom Plantae: Physiology and Reproduction .....</b>	<b>463</b>
Introduction .....	463
How a Plant Depends on Water .....	463
Water Absorption in Plants .....	465
Water Transport in Plants.....	466
Plant Growth .....	469
Insectivorous Plants.....	472
Reproduction in Plants .....	473
Vegetative Reproduction.....	473
Sexual Reproduction in Phylum Anthophyta.....	475
Experiment 15.1: Flower Anatomy .....	478
The Reproductive Process in Anthophytes, Part 1: Forming Pollen and Embryo Sacs.....	480
The Reproductive Process in Anthophytes, Part 2: Pollination .....	482
The Reproductive Process in Anthophytes, Part 3: Fertilization .....	484
Seeds and Fruits .....	485
Experiment 15.2: Fruit Classification .....	487
Germination and Early Growth.....	489
 <b>MODULE #16: Reptiles, Birds, and Mammals .....</b>	 <b>495</b>
Introduction .....	495
Class Reptilia.....	495
Classification of Reptiles .....	498
Order Rhynchocephalia.....	499
Order Squamata.....	499
Lizards.....	500
Snakes.....	501
Order Testudines .....	503
Order Crocodilia.....	504
Dinosaurs.....	505
Class Aves .....	507
Experiment 16.1: Bird Embrology .....	508
A Bird’s Ability to Fly .....	509
Classification in Class Aves.....	514
Experiment 16.2: Bird Identification .....	517
Class Mammalia.....	518
Classification in Class Mammalia.....	520
Summing It All Up.....	526
 <b>Glossary .....</b>	 <b>531</b>
<b>Appendix A.....</b>	<b>543</b>
<b>Appendix B.....</b>	<b>545</b>
<b>Appendix C.....</b>	<b>577</b>
<b>Index.....</b>	<b>583</b>