

brief contents



Chapter 1	Evolution of Evolution	2
Chapter 2	Time	18
Chapter 3	Heredity	40
Chapter 4	Emergence of Life	60
Chapter 5	Diversity of Life	76
Chapter 6	Evidence of Evolution	98
Chapter 7	Selection	122
Chapter 8	Variation: Spice of Life	144
Chapter 9	Speciation	158
Chapter 10	Co-Evolution	176
Chapter 11	Life History Strategies	196
Chapter 12	Life in Groups	206
Chapter 13	Extinctions	226
Chapter 14	Human Evolution: The Early Years	248
Chapter 15	Human Evolution: Building Modern Humans	270
Chapter 16	Evolutionary Biology: Today and Beyond	296
Chapter 17	Afterword	318

contents



Preface xi

Chapter 1 Evolution of Evolution 2



Introduction 3
Philosophical Schools 3
Fact, Course, Mechanism 5
Fixity of Species 6
 Linnaeus 6
 Naturalists 6
Change of Species 7
 J-B. de Lamarck 7
 Upward to Perfection 8

The Mechanism of Evolution:
Natural Selection 9
 A. R. Wallace 9
 Charles Darwin 10
A Most Dangerous Voyage 12
Critics and Controversy 13
Captain and Commander 13
Overview 14

Chapter 2 Time 18



Introduction 19
Dating Fossils 20
 Stratigraphy 21
 Index Fossils 22
 Radiometric Dating 23
Geological Ages 25

"The Age of Bacteria" 28
Fossils and Fossilization 28
 Recovery and Reconstruction 30
 Lewis and Clark—In Search of Mastodons 32
 From Animal to Fossil 36
 Missing Fossils 38
Overview 38

Chapter 3 Heredity 40



Introduction 41
Inheritance by Intuition 41
 Early Intuition 41
 Blending Inheritance 42
Mendelian Inheritance 43
 Gregor Mendel 43
 Testcross 47
 Mendelian Principles of Inheritance 48
 Mendel's Achievement 48

Chromosomes 50
 Cell Division 50
Mendel Amended 52
 Gene Linkage 52
 Multiple Alleles 52
 Multiple Genes—Polygenes 53
 Population Genetics 53
Overview 55

Chapter 4 Emergence of Life 60



Introduction 61
Major Transitions of Life 61
 Inorganic to Organic Evolution
 (4 billion years ago) 62
 Cell—Prokaryotic, Heterotroph
 (3.5 billion years ago) 64
 Cell—Prokaryotic, Autotroph
 (2.7 billion years ago) 64
 Cell—Prokaryote to Eukaryote
 (2 billion years ago) 65
 Multicellularity 66
 Brushing Up on Dental Caries 67
Major Transitions of Life and Consequences 67
 Ozone 67
 Pollutant 67

Eukaryotic Origins 67
Chemical Coding—From Genotype to
 Phenotype 69
 DNA 69
 RNA 69
 Genes 70
Cell Metabolism 71
 Metabolic Pathways 72
 Carbon Fixation 72
 Photosynthesis 73
What Is Life? 73
 An RNA World 73
 A Protein World 73
Overview 74

Chapter 5 Diversity of Life 76



Introduction 77
 Prokaryotes 77
 Bacteria (Eubacteria) 77
 Archaea (Archaeobacteria) 79
 E. coli—Friend and Foe 79
 Eukaryotes 79
 Protists 79

Plants 80
 Fungi 85
 Animals 85
 Fungus among Us 86
 Environment 92
 Overview 95

Chapter 6 Evidence of Evolution 98



Introduction 99
 The Fact of Evolution 100
 The Fossil Record 100
 Comparative Anatomy 102
 Comparative Embryology 106
 Human Appendix—Out of a Job 111

Vestigial and Atavistic Structures 111
 Distributional Evidence 113
 The Course of Evolution 119
 Overview 119

Chapter 7 Selection 122



Introduction 123
 Artificial versus Natural Selection 124
 Artificial Selection 124
 Natural Selection 128
 The Phenotype Takes a Beating 128
 Types of Natural Selection 132
 Stabilizing Selection 132

Directional Selection 133
 Disruptive Selection 134
 Sexual Selection 134
 From Mate to Meal 138
 Overview 140

Chapter 8 Variation: Spice of Life 144



Introduction 145
 Tulips 145
 Mixing It Up 146
 Recombination 146
 Sex 146
 Mutations 147
 Early Work 147

Mistakes Happen 147
 Point Mutations 148
 Gene Duplication 149
 Chromosomal Mutations 149
 Sickle-Cell Anemia: Disease
 against Disease 150
Hox Genes and Their Kingdoms 151
 Overview 155

Chapter 9 Speciation 158



Introduction 159
 Species Definitions 160
 Biological Species 160
 Morphospecies 160
 Paleospecies 160
 Agamospecies 160
 The Process of Species Formation 161
 Four Steps to Speciation 161
 Isolation and Diversification 163
 Accentuated Reproductive and Ecological
 Isolation 163

Reproductive Isolating Mechanisms 164
 Prezygotic Mechanisms 164
 Postzygotic Mechanisms 166
 Natural Selection and RIMs 166
 Patterns of Speciation 167
 Clines 167
 Ring Species 169
 Flaming Retreats 169
 Parallelism and Convergence 172
 Latitudinal Gradients of Species Diversity 172
 Overview 173

Chapter 10 Co-Evolution 176



- Introduction 177
- Competition 177
- Symbiosis—Good, Bad, and Ugly 178
- Plant–Animal Co-Evolution 179
 - Spines and Thorns 179
 - Arms Race 180
 - Chemical Warfare 180
 - Mutualism 181
 - Commensalism 184
- Protective Coloration and Shape 185
 - Camouflage 185
 - Warning Coloration (Aposematic) 186

- Mimicry 187
 - Batesian Mimicry 187
 - Milkweeds and Monarchs on the Move 191
 - Müllerian Mimicry 192
 - Other Types of Mimicry 192
- Overview 193
 - Linkage and Liaisons 193
 - Remodeling 194
 - Complex 195

Chapter 11 Life History Strategies 196



- Introduction 197
- Life History Traits 197
 - Lizards 197
 - Guppies 198
 - Roundabout with Parasites 199

- Time and Energy Budgets 201
 - Abiotic Factors 201
 - Biotic Factors 202
- Overview 204

Chapter 12 Life in Groups 206



- Introduction 207
 - Alarm Calls 207
 - Individual Selection and Group Selection 209
- Altruism versus Selfish Behavior 210
- Kin Selection 210
 - Inclusive Fitness 210
 - Sex—What Good Is It? 211
 - Coefficient of Relationship 212
- Levels of Selection 213

- Microevolution and Macroevolution 214
 - Quantum Evolution 214
 - Punctuated Equilibrium 216
 - Consequences of Punctuated Equilibrium 217
- Rapid Evolution 218
 - On the Edge 219
 - Macro Changes at Micro Levels 221
- Overview 223

Chapter 13 Extinctions 226



- Introduction 227
- Uniform Extinctions 228
 - Co-Evolution 228
 - Islands 229
 - Red Queen 232
 - Assessment of Uniform Extinctions 233
- Mass Extinctions 234
 - Causes of Dinosaur Extinctions 235

- Mass Extinctions—Case Studies 236
 - The North Pole Is Headed South 238
 - Plate Tectonics 238
 - Ice Ages 242
 - Cosmic Collisions 243
- Overview 245

Chapter 14 Human Evolution: The Early Years 248



Introduction 249

“New” Ancestors 250

Pitfalls 250

Human Inevitability 250

Nature versus Nurture 252

Primates 255

Primate Features 255

Primate Evolution 255

The Course of Hominid Evolution 257

Hominid Features 258

Hominid Evolution—

On Becoming Human 261

Hoax 262

Taung Skull—A Child’s Story 262

Lucy—Farther Back in Time 263

Vegetarians—A Dead End 265

Odd Man Out 267

Overview 267

Chapter 15 Human Evolution: Building Modern Humans 270



Introduction 271

On to Modern Hominids 273

Out of Africa 274

Out of Africa—Again 278

Evolving Language—*-thal* or *-tal*? 281

Out of Africa a Third Time 281

Hominid Evolution—

Innovations and Insights 282

Mosaic Evolution 282

Human Variation 283

Physical and Behavioral Features—Real and

Imagined 285

Hairless Bodies 286

Language 287

Religion 288

Wanderlust 290

Out of Africa 290

Arrival of *Homo sapiens* 290

To the Americas 291

Overview 293

Chapter 16 Evolutionary Biology: Today and Beyond 296



Nature Red in Tooth and Claw 297

Enter, Genetic Technology 298

Evolution in Our Hands 302

People, Pathogens, and Plagues 302

A Plague on Your City 303

The Marathon—Stretching It 303

From Gods to Germs 304

Epidemics 305

Viruses 305

Evolving Plagues and Pathogens 306

The Origin of Diseases 307

Co-Evolution of People and Pathogens 309

Humans 309

Friendly Fever 310

Pathogens 310

Emerging Plagues 313

Medical Technology 313

The Magic Bullet 314

Revenge of the Germs 314

Plasmids 315

Antibiotics Everywhere 315

Running Out of Bullets 315

Overview—

Evolution Today and Tomorrow 316

Chapter 17 Afterword 318



Bird Flu 319

Intelligent Design—Even Lice? 320

Appendix 1 Cell Division—A Review 325

Appendix 2 Taxonomy 330

Appendix 3 Molecular Clocks 336

Glossary 339

Credits 345

Index 346