



Understanding
GENES and
GM  **OS**

Colin J Sanderson

 World Scientific

Contents

Preface	vii
Chapter 1. Getting Started	1
1.1 Scientific Jargon	5
1.2 Nucleic Acids, Proteins, Carbohydrates & Lipids	6
1.3 Biotechnology.....	9
1.4 Experimental Organisms	10
1.5 My Example of a Gene.....	12
1.6 What to Expect	17
1.7 Take-Away Message	20
Chapter 2. Life: Cells, Organisms & Evolution	21
2.1 In the Beginning	21
2.2 Metabolism	25
2.3 Cells.....	27
2.4 Viruses.....	34
2.5 Protein Interactions.....	35
2.6 Evolution	36
2.7 The Concept of Genes	43
2.8 Take-Away Message	45
Chapter 3. How Biological Molecules Are Put Together	48
3.1 Nucleic Acids: DNA & RNA	49
3.2 Proteins.....	54
3.3 Carbohydrates.....	65
3.4 Glycosaminoglycans (GAGs).....	69
3.5 Lipids.....	71
3.6 Cell Membranes.....	72
3.7 Take-Away Message	74

Chapter 4. What Is a Gene?	76
4.1 DNA Replication	77
4.2 Genes and the Genome	79
4.3 Mutations.....	89
4.4 Cell Division.....	95
4.5 Sex Determination	98
4.6 Transcription and Translation.....	98
4.7 Mitochondria and Chloroplasts.....	101
4.8 Take-Away Message	101
Chapter 5. How Do Genes Work?	103
5.1 Gene Structure	105
5.2 Regulating Gene Expression.....	108
5.3 Chromatin Structure	117
5.4 How Genes Are Studied	122
5.5 Development of Body Shape.....	125
5.6 Viruses.....	128
5.7 The New World of RNA	129
5.8 How Sex Works.....	132
5.9 Take-Away Message	138
Chapter 6. Genetic Engineering	141
6.1 Working with DNA	142
6.2 Gene Cloning.....	150
6.3 Protein Expression Systems.....	154
6.4 Transgenic Animals.....	158
6.5 Transgenic Plants.....	160
6.6 Gene Modifications	163
6.7 Take-Away Message	167
Chapter 7. DNA Amplification & Analysis	168
7.1 Polymerase Chain Reaction (PCR).....	168
7.2 DNA Sequencing.....	171
7.3 Mutagenesis by PCR	174
7.4 SNP and STR Genetic Markers	175
7.5 Microarrays.....	180
7.6 Take-Away Message	183
Chapter 8. Genes in the Natural World	184
8.1 Natural Gene Flow	185
8.2 Junk DNA.....	187
8.3 Geographical Gene Flow: Animals.....	190
8.4 Geographical Gene Flow: Exotic Plants	193

8.5 GM Plants.....	194
8.6 GM Animals.....	196
8.7 Gene Transfer from Plants to Animals.....	199
8.8 Bioleaching of Metals in Mining.....	200
8.9 Genes in Remediation.....	201
8.10 Take-Away Message.....	203
Chapter 9. People & Our Genes	204
9.1 Our History.....	204
9.2 Human Migration.....	206
9.3 Race.....	209
9.4 Red Hair.....	211
9.5 Genetic Profiling.....	213
9.6 Genetic Disease.....	215
9.7 Sex-Linked Genetic Disease.....	217
9.8 Mutations in Haemoglobin.....	219
9.9 Cystic Fibrosis.....	223
9.10 Gene Therapy.....	226
9.11 RNA Inhibition (RNAi).....	228
9.12 Multi Gene Effects: Asthma.....	229
9.13 Take-Away Message.....	233
Chapter 10. Genetics of Some of Our Pathogens	235
10.1 Tuberculosis.....	236
10.2 The Pasteurella Group.....	243
10.3 Influenza.....	245
10.4 Take-Away Message.....	252
Chapter 11. Biotechnology & Sustainable Agriculture	254
11.1. Improved Crops.....	255
11.2 Growing or Eating GM.....	256
11.3. Sustainable Agriculture.....	257
11.4 Certified Organic Farming.....	258
11.5 Reliability and Profitability of Food Production.....	262
11.6 Three Elements of Profitable Farming.....	263
11.7 Plant Nutrition.....	265
11.8 Pest Management.....	268
11.9 Pesticide Resistance.....	270
11.10 Traditional Breeding & Biotechnology.....	271
11.11 Take-Away Message.....	275

Chapter 12. GMOs in Agriculture	276
12.1 Seed Fertilisation and Viability	277
12.2 Herbicide Resistance	282
12.3 Insect Resistance	286
12.4 Phosphate Uptake	288
12.5 Nitrogen Metabolism.....	290
12.6 Resistance to Abiotic Stress.....	295
12.7 Disease Resistance.....	300
12.8 Golden Grains.....	302
12.9 Iron Enriched Plants	305
12.10 Improved Vegetables.....	307
12.11 Forest Trees	309
12.12 Take-Away Message	313
Chapter 13. Patents, Regulations & the Future	315
13.1 Patenting Genes	317
13.2 Patenting Organisms.....	319
13.3 Testing Drugs and Food	321
13.4 Tomorrow’s Natural World.....	323
13.5 Health in the Future	325
13.6 GM Food. A World Snapshot.....	326
13.7 A Little Dream.....	332
Glossary	335
Index	341