
Contents

Foreword	xv
Acknowledgments.....	xvii
Authors.....	xix
Chapter 1 Introduction	1
Aims and Purpose	1
Importance and Role of Natural Products.....	1
Organic Chemistry	5
A Note on the Scope.....	7
A Note on Nomenclature.....	7
A Note on Botanical Names.....	7
A Note on References.....	7
Chapter 2 Medical Marvels.....	11
Introduction	11
Ancient Medicine	11
Central America's Humble Potato!.....	13
Steroids	13
Ancient Forms of Contraception	13
The Search for the Modern Birth Control Pill: The Hormones, Estrogen and Progesterone	14
Isolation of Natural Diosgenin from the Mexican Yam	15
Chemical Magic in the Laboratory: Synthesis of Norethindrone	16
Biological Studies of Progesterone to Prevent Ovulation	17
Medical Approval and Social Acceptance	17
The Profound Social, Cultural and Economic Impacts of Reliable, Oral Contraception	18
Transformation: Global Emergence of the Yam.....	18
Hydrocarbons	19
Saturated Hydrocarbons	19
Alkanes	19
Cycloalkanes.....	19
Crude Oil and Industrial Fractional Distillation	20
Benzene and Aromatic Compounds: Physical and Chemical Properties.....	22
Theory of the Molecular Structure of Benzene.....	23
Summary of the Characteristics of Aromatic Compounds	24
Europe Solves a Headache! Emergence of Aspirin.....	26
Salicin and Salicylic Acid.....	26
Carboxylic Acids	26
Phenol and Phenolic Compounds.....	27

Acetylation of the Hydroxyl Group of Salicylic Acid to Form Aspirin.....	28
Attacking Malaria: A South American Treasure (but Not Gold) and a Chinese Miracle.....	31
Malaria	31
Cinchona.....	32
Isolation of Quinine.....	32
Synthesis of Quinine in the Laboratory	33
Uses of Quinine.....	33
Artemisinin.....	34
Carbon–Oxygen Single Bonds and Oxygen–Oxygen Single Bonds in Organic Compounds	34
The Peroxide Link and the Peroxide Bridge in Artemisinin.....	36
A Steroid in Your Garden.....	38
The Foxglove and Digoxigenin	38
Esters Are Formed from Alcohols and Acids	40
Properties and Uses of Esters	41
Introducing Cyclic Esters Known as Lactones.....	42
Lactones as Building Blocks in Nature	42
Vitamins	42
Vitamin C, Ascorbic Acid	43
Commercial Uses of Lactones.....	44
Africa’s Gift to the World.....	46
Discovery of the Periwinkle Plant and Its Properties	46
Serendipity.....	47
Angela’s Story.....	48
Modern Research and Therapeutic Value	48
The Alkaloids, Vincristine and Vinblastine.....	49
Isolation of Vincristine and Vinblastine from Plants	50
Fractional Distillation.....	50
Acid–Base Extraction	50
Saving the Pacific Yew Tree.....	52
The Nature of Paclitaxel.....	52
Medical Value of Paclitaxel.....	53
Modern-Day Preparation of Paclitaxel.....	53
Terpenes and Isoprene as a Building Block in Nature	53
Isomers	54
Isomers and Stereochemistry	54
Isomers and Chirality	55
Nuclear Magnetic Resonance (NMR) Spectroscopy and Molecular Structure.....	56
Chapter 3 Modern Miracles of Foods and Ancient Grains.....	59
Introduction	59
Rediscovering Traditional Grains of the Americas: Chia and Quinoa....	60

Chia	60
Quinoa	61
Gluten Sensitivity	61
Lipids	62
Fats, Oils and Human Health	63
Waxes.....	64
Vegetable Oil and Biodiesel	64
Foods of the Fertile Crescent: Ancient Wheat	66
Possible Origins of Ancient Wheat	66
Crop Domestication.....	67
Crop Germination.....	67
Phenylpropanoids	68
Lignans	68
Lignin	69
Major Cultivated Species of Wheat.....	69
Modern Wheat.....	70
Wheat Genetics.....	71
Nutritional Importance of Wheat and Grinding.....	71
Importance of Proteins	72
Peptide Bond.....	73
The Condensation Reaction.....	73
Proteins and Amino Acids	74
The Molecular Structure of Proteins and NMR.....	75
Fascinating Influence of Chirality on Life Systems on Earth.....	76
The Shikimic Acid Pathway	76
Eugenol and Rosmarinic Acid.....	78
Society's Challenges in Enhancing Agricultural Production: Crop Yield and "Green Issues" Including Genetic Modification of Crops.....	78
Asian Staple: Rice	82
Carbohydrates and Saccharides: Oxygen in the Organic Ring	82
Monosaccharides	83
Disaccharides	83
The Glycoside Link	84
Oligosaccharides.....	85
Polysaccharides	85
Chemical Properties of Carbohydrates: Monosaccharides	86
The Value of Monosaccharides, Disaccharides and Polysaccharides to Living Organisms	87
Human Nutrition.....	87
Commercial Uses of Carbohydrates.....	87
Brewing of Beer.....	87
Adhesives and Stiffening Agents in Fabrics.....	88
Bioplastic	88
Explosives	89
Chinese Cordyceps: Winter Worm, Summer Grass.....	90

	The Life Cycle of <i>Cordyceps sinensis</i>	90
	The Perceived Health Benefits of <i>Cordyceps sinensis</i>	90
	What Is Fermentation?.....	93
	Chemistry of Fermentation: Redox Reactions	93
	Industrial Production of Bioethanol	94
	Garlic and Pungent Smells	96
	Garlic	96
	Organosulfur Compounds	97
	Amino Acids Which Contain Sulfur.....	97
	Fossil Fuels and Air Pollution	99
Chapter 4	Beverages.....	101
	Introduction	101
	Tea: From Legend to Healthy Obsession!	102
	The Growing and Processing of Tea	104
	Tea as a Modern Medicine	105
	Green Tea Helps against Cancer	106
	Catechins: Key Phenolic Constituents in Green Tea.....	106
	The Properties of Phenol and Phenols.....	107
	Phenols Compared with Alcohols	107
	Electrophilic Substitution Reactions of Phenol	108
	Interaction with Light in the Visible Part of the Spectrum of Electromagnetic Radiation	108
	Cocoa (Cacao): Food of the Gods	110
	Origins	110
	Cacao and the Aztecs	110
	Processing Cacao Beans.....	111
	Cocoa and Cardiac Health.....	112
	Cocoa and Diabetes	112
	Chemical Constituents of Cocoa	113
	Free Radicals and Antioxidants.....	113
	Flavonoids (or Polyphenols).....	113
	Coffee: Wake Up and Smell the Aroma!.....	115
	Early Use	116
	Coffee and Caffeine.....	117
	Zwitterions.....	118
	Cyclic Aromatic Amines.....	118
	The Process of Decaffeination of Coffee	119
	Maca from the High Andes in South America	122
	The Maca Plant.....	122
	Maca as a Beverage and a Food	122
	The Medicinal Value of Maca	123
	Chemical Composition of Maca	123
	Indole	124
	Key Chemical Properties of Indole	124

Electrophilic Substitution	124
Indole and Bases	125
Acid–Base Extraction	125
Purification of Indole Alkaloids by Acid–Base Extraction	125
Indole Alkaloids	126
Strychnine	126
Ergotamine	127
Lysergic Acid Diethylamide (LSD)	127
Curare	128
Chapter 5 Euphorics	131
Introduction	131
Morphine: A Two-Edged Sword	132
Joe and Mike: The Two-Edged Sword	132
Production of Morphine in the Natural World	134
Purification, Chemical Composition and Properties of Morphine	135
Chemical Composition and Properties of Codeine	136
Chemical Composition and Properties of Heroin	136
Medicinal Uses of Morphine	138
Summary	138
Cannabis and Marijuana	140
Cannabis	140
Introducing Cannabinoids	140
Terpenes	141
Classification of Terpenes	142
Terpenes and Elimination Reactions	142
The Condensation Reaction	143
Coca and Cocaine	145
Coca and the Coca Plant	145
Cocaine	145
Chemical Properties of Cocaine	146
Isolation of Cocaine	147
Legitimate Applications of Cocaine	147
Tobacco: A Profound Impact on the World	149
Tobacco	149
Nicotine	151
Amines	151
Heterocyclic Aromatic Compounds	151
Pyridine	152
Pyrrole	152
Thiophen	152
Amides	153
Properties of Nicotine	154
Uses of Nicotine	154

	Agriculture.....	154
	Human Health and Pharmacy.....	155
Chapter 6	Exotic Potions, Lotions and Oils.....	157
	Introduction.....	157
	A Plant from the East Indies: Camphor.....	158
	The Classification and Structure of Camphor.....	158
	Diverse Uses of Camphor.....	158
	Extraction of Camphor by Steam Distillation.....	159
	The Carbonyl Group and Nucleophilic Addition Reactions.....	160
	Infrared Spectroscopy and the Determination of the Structure of Organic Molecules.....	161
	Absorption of Infrared Radiation: The Greenhouse Effect and Global Warming.....	161
	Biblical Resins: Frankincense and Myrrh.....	165
	Sources and Uses of Frankincense and Myrrh.....	165
	Frankincense.....	166
	Myrrh.....	168
	Classification of Cyclic Terpenes.....	168
	Steric Hindrance.....	171
	European Lavender.....	173
	European Lavender.....	173
	Distribution.....	174
	Value of Lavender.....	175
	Food and Drink.....	175
	Medicinal Applications.....	175
	Cosmetics.....	175
	Soap and Detergent.....	175
	Essential Oils: Hydrosol from Lavender.....	175
	Hydrosols and Colloids.....	176
	Vegetable Oils and Fats.....	176
	Glycerol.....	177
	Triglycerides.....	177
	Hydrolysis of Esters.....	177
	Soap.....	177
	How Soap Works.....	178
	Global Aloe.....	180
	<i>Aloe vera</i>	180
	<i>Aloe vera</i> and Skin Treatment.....	181
	<i>Aloe vera</i> and Polysaccharides.....	181
	Galactomannans.....	181
	Hydraulic “Fracking”.....	182
	Anthraquinones Found in <i>Aloe vera</i>	183
	Aloin.....	183
	Emodin.....	184

Chromatography	185
Thin-Layer and Column Chromatography	185
Gas Chromatography and Gas–Liquid Chromatography.....	186
High-Pressure Liquid Chromatography	186
Ion-Exchange Chromatography.....	186
Chapter 7 Colorful Chemistry: A Natural Palette of Plant Dyes and Pigments.....	189
Introduction	189
Our World of Green Plants: Human Survival	191
Green Plants	192
Flowering Plants and Conifers	192
Algae.....	192
Lichens.....	192
The Vital Process of Photosynthesis	193
Chlorophyll.....	193
Chlorophyll and Color	195
Chromophores	195
Molecular Interaction with Electromagnetic Radiation	197
Ultraviolet Absorption Spectroscopy and Organic Chemistry....	198
Ultraviolet Absorption Spectroscopy and Molecular Structure ..	199
Green Plants and Limiting Climate Change	200
Saffron and Carotenoids: Yellow and Orange Dyes	204
Saffron: The Plant	204
Crocin: The Extract from Saffron	205
Carotenoids and Autumnal Colors	205
Carotenoids, Carotenes and Xanthophylls	207
Carotenes	207
β -Carotene.....	207
Lycopene.....	207
Isolation and Extraction.....	208
Xanthophylls.....	208
Crocin	208
Lutein.....	208
The Allyl Functional Group	209
Human Health: Vitamin A, Retinol and Retinal.....	210
Woad (<i>Isatis tinctoria</i>) and Indigo	212
Indigo through the Ages	212
Indigo from Plants	213
Extraction of Indigo.....	214
Physical and Chemical Properties of Indigo	214
Indigo and Dyeing Textiles.....	215
Levi Strauss and Wrangler Jeans.....	215
“Lincoln Green” Worn by Robin Hood.....	215
Azo Dyes	217

Red Dyes from Henna, Dyer's Bugloss and Madder.....	220
Quinones as Building Blocks in Nature	220
Naphthoquinones	221
Lawson, a Red-Orange Dye from Henna.....	221
Alkannin, a Red-Brown Dye from Dyer's Bugloss	222
Anthraquinones	222
Alizarin Red from Madder Root	223
Parietin from the Lichen, <i>Xanthoria parietina</i>	223
Textile Dyes: Colorfastness and Mordants	225
Solubility of Dyes in Water.....	225
Colorfastness.....	225
Mordants	225
Reversible Colors in Flowers, Berries and Fruit	228
The Inestimable Value of Color in Flowers, Berries and Fruit ...	228
The Beautiful Color of Autumn Leaves	229
Flavonoids.....	229
Flavonoids and Anthocyanins	230
Anthocyanins: Reversible Dyes.....	231
Reversible Dyes and Acid/Base Indicators.....	231
Litmus	231
Methyl Red and Methyl Orange	232
Phenolphthalein	233
Phytochrome: A Reversible Pigment and a Biological Light Switch: Photoperiodism.....	233
Glossary	237
Index	243