

Contents

Preface — V

Abbreviations and Icons — XI

1 Introduction to Animal Toxins — 1

- 1.1 What Are Toxins? — 1
- 1.2 Organisms as Sources for Toxic Compounds — 2
- 1.3 Structure and Function of Animal Toxins — 5
- 1.4 Evolutionary Origins of Animal Toxins — 7
- 1.5 Toxicokinetics of Animal Toxins — 10
- 1.6 Toxicodynamics of Animal Toxins — 13
- 1.7 Animal Toxins and Human Health — 15
- 1.8 Therapeutic Approaches upon Intoxication in Humans — 17

2 Chemistry, Pharmacology, and Toxicology of Animal Toxins — 19

- 2.1 Aliphatic Acids — 19
- 2.2 Polyynes — 21
 - 2.2.1 General — 21
 - 2.2.2 Polyynes of Sponges (Porifera) — 22
- 2.3 Polyketides — 23
 - 2.3.1 General — 23
 - 2.3.2 Acanthifolicin — 26
 - 2.3.3 Aplysiatoxin — 27
 - 2.3.4 Brevetoxins — 27
 - 2.3.5 Bryostatins — 28
 - 2.3.6 Halichondrins — 28
 - 2.3.7 Palytoxin — 28
 - 2.3.8 Pederin — 30
 - 2.3.9 Okadaic Acid — 30
 - 2.3.10 Maitotoxin — 30
- 2.4 Terpenes — 33
 - 2.4.1 General — 33
 - 2.4.2 Monoterpenes — 34
 - 2.4.3 Cantharidin — 37
 - 2.4.4 Sesquiterpenes — 38
 - 2.4.5 Diterpenes — 41
 - 2.4.6 Sesterterpenes — 44
 - 2.4.7 Triterpenes — 44
- 2.5 Steroids — 48
 - 2.5.1 General — 48

2.5.2	Steroids as Defensive Molecules in Animals —	49
2.6	Saponin-Like Triterpenes and Steroid Derivatives —	56
2.6.1	General —	56
2.6.2	Saponin-Like Steroid Derivatives of Sponges (Porifera) —	59
2.6.3	Saponin-Like Steroid Derivatives of Corals (Anthozoa) and Beetles (Coleoptera) —	60
2.6.4	Saponin-Like Steroid Derivatives of Echinoderms (Echinodermata) —	61
2.6.5	Saponin-Like Steroid Derivatives of Cartilaginous Fish (Chondrichthyes) and Bony Fish (Osteichthyes) —	66
2.7	Phenylpropanoids —	70
2.7.1	General —	70
2.7.2	Phenylpropanoids in Arthropod Defense Secretions —	70
2.8	Amines —	73
2.8.1	Tetramethylammonium —	73
2.8.2	Acetylcholine —	75
2.8.3	Other Choline Esters —	75
2.8.4	Nereistoxin —	76
2.8.5	Phenylalkylamines —	76
2.8.6	Indole and Imidazole Alkylamines —	78
2.9	Alkaloids —	81
2.9.1	General —	81
2.9.2	Imidazole Alkaloids —	85
2.9.3	Zoanthamine Alkaloids —	87
2.9.4	Pyrrolizidine Alkaloids —	87
2.9.5	Pyridoacridine Alkaloids —	89
2.9.6	Piperidine Alkaloids —	89
2.9.7	Quinazoline Alkaloids —	90
2.9.8	Pyridine Alkaloids —	91
2.9.9	Pyrimidine Alkaloids —	94
2.9.10	Quinoline Alkaloids —	94
2.9.11	Quinolizidine Alkaloids —	96
2.9.12	Isoquinoline Alkaloids —	97
2.9.13	Indole Alkaloids —	98
2.9.14	Purine Alkaloids —	100
2.9.15	Terpene Alkaloids —	102
2.9.16	Steroid Alkaloids —	103
2.9.17	Polyamine Alkaloids —	106
2.9.18	Azaphenalene Alkaloids —	106
2.10	Cyanogenic Compounds —	114
2.11	Glucosinolates —	117
2.12	Proteins and Peptides —	120
2.12.1	General —	120

2.12.2	Enzymes —	124
2.12.2.1	Proteases —	125
2.12.2.2	Phospholipases —	127
2.12.2.3	Hyaluronidases —	128
2.12.2.4	Deoxyribonucleases, Ribonucleases, and Nucleosidases —	129
2.12.2.5	Esterases and Apyrases —	129
2.12.2.6	Amino Acid Oxidases —	130
2.12.3	Cytotoxins —	130
2.12.4	Neurotoxins —	131
2.12.5	Myotoxins —	133
2.12.6	Cardiotoxins —	134
2.12.7	Hemotoxins —	135
2.12.8	Allergens —	138
2.12.9	Lectins —	139
2.12.10	Antimicrobial Peptides and Proteins —	140

3 Venomous and Poisonous Animals — 147

3.1	Synergism of Venom Components —	147
3.2	Animals Producing Poisons or Venoms and Modes of Their Actions —	147
3.2.1	Sponges (Porifera) —	147
3.2.2	Cnidaria —	155
3.2.2.1	Anthozoa —	155
3.2.2.2	Cubozoa and Scyphozoa —	159
3.2.2.3	Hydrozoa —	164
3.2.3	Mollusca —	170
3.2.3.1	Snails and Slugs (Gastropoda) —	170
3.2.3.2	Bivalvia —	173
3.2.3.3	Cephalopoda —	174
3.2.4	Echinodermata —	177
3.2.4.1	Sea Urchins (Echinoidea) —	177
3.2.4.2	Sea Stars (Asteroidea) —	180
3.2.4.3	Sea Cucumbers (Holothuroidea) —	181
3.2.5	Worms —	182
3.2.5.1	Flat Worms (Plathelminthes) —	182
3.2.5.2	Ribbon Worms (Nemertea) —	183
3.2.5.3	Ringed Worms (Annelida) —	184
3.2.6	Tunicata —	191
3.2.7	Arachnida —	192
3.2.7.1	Spiders (Araneae) —	193
3.2.7.2	Scorpions (Scorpiones) —	201
3.2.7.3	Mites (Acari) —	208

3.2.8	Myriapoda —	213
3.2.8.1	Diplopoda —	213
3.2.8.2	Chilopoda —	214
3.2.9	Insects (Hexapoda) —	217
3.2.9.1	Insects with Stinging or Biting Mouthparts —	217
3.2.9.2	Hymenoptera —	224
3.2.9.3	Beetles (Coleoptera) —	235
3.2.9.4	Stick Insects (Phasmatodea) —	242
3.2.9.5	Caterpillars of Butterflies (Lepidoptera) —	242
3.2.10	Crustacea —	250
3.2.11	Fishes (Pisces) —	252
3.2.12	Amphibia —	263
3.2.12.1	Frogs and Toads (Anura) —	264
3.2.12.2	Salamanders (Urodela) —	269
3.2.12.3	Caecilians (Apoda) —	271
3.2.13	Reptiles and Birds (Sauropsida) —	272
3.2.13.1	Lizards (Squamata) —	272
3.2.13.2	Snakes (Serpentes) —	275
3.2.13.3	Birds (Aves) —	303
3.2.14	Mammals (Mammalia) —	308

Poison Information Centers — 315

Index — 317