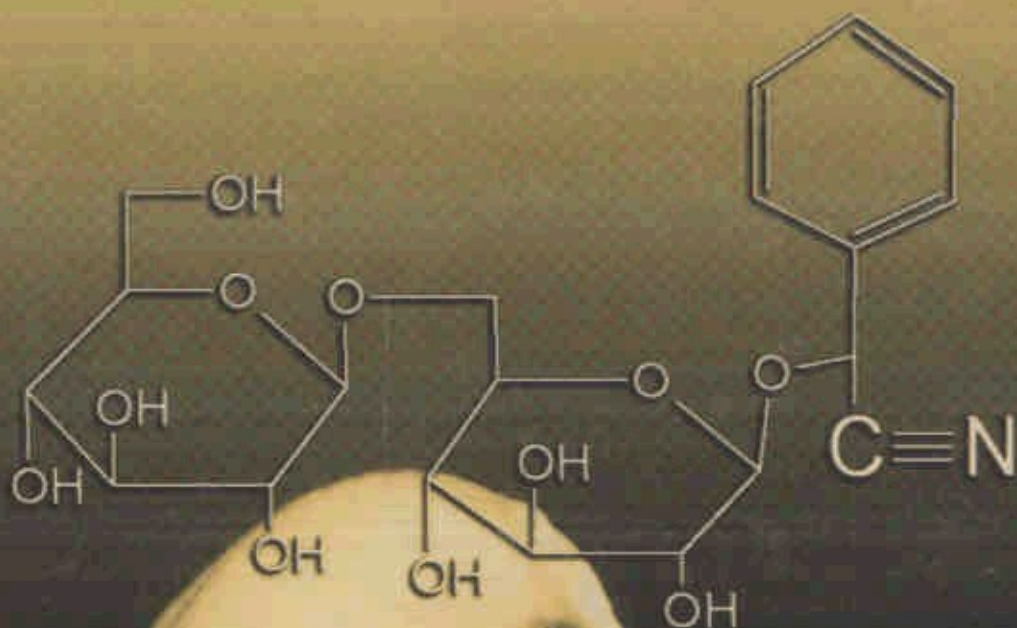


PRINCIPLES OF FOOD TOXICOLOGY



Tõnu Püssa



CRC Press
Taylor & Francis Group

Contents

<i>Preface</i>	xv
<i>Acknowledgments</i>	xvii
<i>Author</i>	xix
Section I: Basics of toxicology connected to food	1
Chapter 1 Introduction	3
1.1 What is toxicology?	3
1.2 Short history of toxicology	5
1.3 Toxicity dose and response	7
1.4 Interaction of toxic substances	14
1.5 Classification of toxicants	15
1.6 Some toxicology-related principles of cellular biology and biochemistry	16
1.6.1 Structure of cellular membranes	16
1.6.2 Transport of substances across biomembranes	17
1.6.3 Receptors	20
References	22
Chapter 2 Routes of xenobiotics in an organism	23
2.1 Entry and absorption of foreign compounds	23
2.1.1 Digestive tract	24
2.1.2 Lungs	25
2.1.3 Skin	26
2.2 Distribution of xenobiotics in an organism	27
2.2.1 Blood supply and membrane barriers	27
2.2.2 Binding of xenobiotics to charged particles	28
2.2.3 Bioaccumulation of xenobiotics	29
2.3 Metabolism of xenobiotics	30
2.3.1 General principles	30
2.3.2 Phase I reactions	33
2.3.2.1 Enzyme superfamily CYP	33

2.3.2.2	Other enzymes, catalyzing oxidation	34
2.3.2.3	Examples of phase I reactions	35
2.3.3	Phase II reactions	38
2.3.4	Induction and inhibition of metabolic enzymes	42
2.3.4.1	Induction of enzymes	42
2.3.4.2	Inhibition of enzymes	44
2.3.5	Participation of enteric microflora in the metabolism of xenobiotics	45
2.3.6	Influence of diet on metabolism	46
2.4	Elimination of xenobiotics and their metabolites from organism	47
2.4.1	Kidneys	48
2.4.2	Liver	49
2.4.3	Intestines	50
2.4.4	Lungs	50
2.5	Biomagnification	51
2.6	Antidotes	52
2.6.1	General methods	52
2.6.2	Specific mechanisms of antidote action	53
	References	54

Chapter 3	Toxic response	55
3.1	Variability of toxic response	55
3.2	Types of toxic response	56
3.2.1	General principles	56
3.2.2	Direct injury of a cell or tissue	59
3.2.3	Biochemical damage	60
3.2.4	Neurotoxicity	61
3.2.5	Immunotoxicity	62
3.2.6	Teratogenicity	63
3.2.7	Genotoxicity and mutagenicity	65
3.2.8	Carcinogenicity	68
3.2.9	Endocrine disruption	74
3.3	Molecular mechanisms of toxicity	78
3.3.1	Disturbance of cell homeostasis	78
3.3.2	Receptor-mediated mechanisms	79
3.3.3	Other toxic effects mediated by cellular membranes	81
3.3.4	Alteration of cell energetics	82
3.3.5	Covalent binding to essential cellular macromolecules	83
3.3.6	Oxidative stress	83
3.3.7	Inhibition of DNA repair	85
3.3.8	Multiple interorgan effects	85
3.4	Biomarkers of toxic effect	86
	References	89

Chapter 4 Analytical toxicology: Determination of foreign compounds	91
4.1 General principles	91
4.2 Hyphenated chromatographic and spectrophotometric methods	92
4.3 Immunological methods for sample preparation and analysis	96
4.3.1 Immunoaffinity columns	96
4.3.2 Enzyme-linked immunosorbent assay	97
References	97
Chapter 5 Evaluation of toxicity of substances	99
5.1 Epidemiological studies	99
5.2 Animal tests	101
5.2.1 General principles	101
5.2.2 Organism-independent factors influencing compound toxicity	105
5.2.2.1 Dependence on species	105
5.2.2.2 Genetic variabilities	106
5.2.2.3 Generic variabilities	106
5.2.2.4 Dependence on age	107
5.2.2.5 Dietary conditions	108
5.2.2.6 Health conditions	109
5.2.2.7 Simultaneous contact with several xenobiotics	110
5.3 Cell culture tests	110
5.4 Computer calculations	112
5.5 Acute toxicity tests	113
5.6 Subacute/subchronic toxicity tests	114
5.7 Chronic toxicity tests: Acceptable daily intake	115
5.8 Other toxicity tests	116
References	117
Chapter 6 Toxicological safety and risk analysis	119
6.1 Toxicological safety	119
6.2 Risk assessment	120
6.2.1 Hazard identification: Principle of the three Rs	121
6.2.2 Demonstration of a dose–response relationship	122
6.2.3 Assessment of exposure	124
6.2.4 Risk characterization	124
References	127
Chapter 7 Internet sources of toxicological information	129
7.1 Pesticide residues	129
7.2 Food additives	130
7.3 Food allergens	130
Reference	130

Section II	Main groups of food-borne toxicants	131
Chapter 8	Endogenous plant toxicants	133
8.1	Lectins or hemagglutinins	133
8.2	Enzyme inhibitors	134
8.3	Alkaloids	135
8.3.1	Pyrrolizidine alkaloids	135
8.3.2	Solanine-group glycoalkaloids	137
8.3.3	Xanthine alkaloids	139
8.3.4	Ephedrine alkaloids	141
8.4	Cyanogenic glucosides: Toxicity mechanism of HCN	142
8.5	Phytoestrogens	145
8.6	Glucosinolates	146
8.7	Coumarin	147
8.8	Thujones	148
8.9	Anisatine	150
8.10	Toxic amino acids	150
8.11	Toxic lipids	153
8.11.1	Erucic acid	153
8.11.2	Sterculic and malvalic acids	154
8.11.3	Polyunsaturated fatty acids	154
8.12	Oxalates	154
8.13	Fluoroacetates	155
8.14	Bracken toxins	156
8.15	Saponins	157
8.16	Grayanotoxin	159
8.17	Mushroom toxins	160
8.17.1	General principles	160
8.17.2	Amatoxins	161
8.17.3	Muscarine	163
8.17.4	Isoxazoles	164
8.17.5	Other mushroom toxins	165
	References	166
Chapter 9	Geochemical pollutants that plants absorb from soil	169
9.1	Arsenic	169
9.2	Selenium	171
9.3	Fluorine	173
	References	174
Chapter 10	Environmental pollutants	177
10.1	Toxic chemical elements	177
10.1.1	Mercury	177

10.1.2	Lead	179
10.1.3	Cadmium	181
10.1.4	Chromium	183
10.1.5	Copper	184
10.1.6	Nickel	185
10.2	Radionuclides	185
10.3	Polychlorinated biphenyls	187
10.4	Polychlorinated dibensodioxins and dibensofurans	189
References		193
Chapter 11	Mycotoxins	195
11.1	Overview	195
11.2	Aflatoxins	195
11.3	Ochratoxins	199
11.4	Sterigmatocystin	200
11.5	Zearalenone	201
11.6	Fumonisin	202
11.7	Trichothecenes	203
11.8	Patulin	204
11.9	Citrinin and citreoviridin	205
11.10	Ergot toxins	206
11.11	Other mycotoxins	207
11.12	Combined toxicity of mycotoxins	207
References		209
Chapter 12	Animal endogenous poisons	211
12.1	Prions	211
12.2	Lactose	213
12.3	Phytanic acid	214
12.4	Avidin	214
12.5	Vitamins of animal origin	214
References		215
Chapter 13	Food toxins from sea	217
13.1	Shellfish toxicants	217
13.1.1	Paralytic shellfish poisoning	217
13.1.2	Diarrhetic shellfish poisoning	220
13.1.3	Neurotoxic shellfish poisoning	222
13.1.4	Amnesic shellfish poisoning	222
13.1.5	Microcystins and nodularins	223
13.2	Fish toxins	224
13.2.1	Tetrodotoxin	224
13.2.2	Ciguatoxin	226
References		228

Chapter 14	Pesticide residues	231
14.1	General principles	231
14.2	Insecticides	238
14.3	Herbicides	238
14.4	Fungicides	239
	References	239
Chapter 15	Veterinary drugs and feed additives	241
15.1	Antibiotics	241
15.2	Hormones	242
15.3	Other veterinary drugs	243
15.3.1	Coccidiostatics	243
15.3.2	Anthelmintics	244
15.3.3	β -agonists	245
15.3.4	Glucocorticoids	245
15.3.5	Thyreostatics	245
	References	246
Chapter 16	Toxicants unintentionally entering food during processing, storage, and digestion	247
16.1	General	247
16.2	Polycyclic aromatic hydrocarbons	250
16.3	Alcohols	252
16.4	Bacterial toxins	255
16.4.1	Exotoxins	255
16.4.1.1	Staphylococcus	255
16.4.1.2	Clostridia	256
16.4.1.3	<i>Bacillus cereus</i>	259
16.4.1.4	Campylobacters	260
16.4.1.5	Listeria	260
16.4.2	Endotoxins	261
16.5	Biogenic vasoactive amines	263
16.5.1	Scombroid poisoning	264
16.6	Nitrates, nitrites, and nitrosamines	266
16.7	Acrylamide	269
16.8	Chlorinated propanols	270
16.9	Phthalates	271
16.10	Bisphenols	274
	References	274
Chapter 17	Food additives	277
17.1	Traditional food additives	277
17.1.1	General principles	277
17.1.2	Colorants	280
17.1.3	Sweeteners	281

17.1.4	Preservatives	283
17.1.5	Antioxidants	283
17.2	Functional additives	283
17.2.1	General principles	283
17.2.2	Functional additive–drug interactions	287
	References	288
Chapter 18	Vitamins	291
18.1	General	291
18.2	Vitamin A: Phenomenon of smokers	292
18.3	Vitamin D	295
18.4	Vitamin E	295
18.5	Vitamin K	297
18.6	Vitamin B ₂	297
18.7	Vitamin B ₆	298
18.8	Vitamin C	298
18.9	Vitamin B ₃	299
18.10	Diagnosing and therapy of vitamin intoxications	299
	References	300
Chapter 19	Glossary	301
	Index	313