

CONTENTS

How to use the Encyclopedia	xli
Glossary of Selected Terms	xlili
Abbreviations of Technical Terms	xlix

VOLUME 1 History, Science and Methods

History, Science and Methods

History of Food Safety and Related Sciences

History of Foodborne Disease – Part I – Ancient History	<i>M Satin</i>	1
History of Foodborne Disease – Part II – The Greek and Roman Periods (1200 BCE–CE 500)	<i>M Satin</i>	7
History of Foodborne Disease – Part III – The Renaissance and the Enlightenment (CE 1300–1750)	<i>M Satin</i>	11
History of Foodborne Disease – Part IV – Modern Times (CE 1900–Present Day)	<i>M Satin</i>	15
History of Foodborne Disease in Asia – Examples from China, India, and Japan	<i>GG Moy and F Han</i>	22

Disciplines Associated with Food Safety

Food Microbiology	<i>MR Adams</i>	28
Parasitology	<i>GW Esch, KE Luth, and MR Zimmermann</i>	33
Food Virology	<i>RM Goulter-Thorsen and L-A Jaykus</i>	41
Epidemiology	<i>E Scallan</i>	47
Food Safety Toxicology	<i>FGR Reyes and PC Binsfeld</i>	53

Risk Analysis

Risk Analysis of Hazards in Food: An Overview	<i>GG Moy</i>	59
Risk Assessment: Principles, Methods, and Applications	<i>LGM Gorris and C Yoe</i>	65
Estimating the Burden of Foodborne Disease	<i>RJ Lake, CE Stein, and AH Havelaar</i>	73
Risk Assessment: Microbiological Hazards	<i>T Ross</i>	80
Risk Assessment: Chemical Hazards	<i>GG Moy</i>	93
Risk Management: Application to Chemical Hazards	<i>SA Slorach</i>	98
Risk Management: Application to Biological Hazards	<i>Y Motarjemi and GG Moy</i>	106
Risk Communication	<i>LJ Frewer and ARH Fischer</i>	116
Risk Communication: Chemical Hazards	<i>M Dreyer and O Renn</i>	122
Risk Communication: Biological Hazards	<i>Y Motarjemi and T Ross</i>	127
Risk Communication: Novel Foods and Novel Technologies	<i>CG Brunk</i>	133

- Risk Communication: Diet, Nutrition, and Health *E van Kleef, KT Verkooijen, and LJ Frewer* 138
Food Safety Training and Health Education: Principles and Methods *C Griffith and E Redmond* 142

Analytical Methods

- Overview of Methods of Analysis for Chemical Hazards *H Senyuva* 152
Transmissible Spongiform Encephalopathy Diagnosis *AJ Raeber and B Oesch* 159

Hazards and Diseases

Characteristics of Foodborne Hazard and Diseases

- Pathogenesis and Virulence *RA Stein and M Chirilă* 166
Microbial Stress Response *CER Dodd* 183
Sublethally Injured and Viable but Nonculturable Cells *BM Mackey* 188
Drug Resistant Pathogens *RA Stein and M Chirilă* 196
Cost of Foodborne Diseases *JC Buzby* 208
International Classification of Diseases *R Jakob and A Tritscher* 217

Foodborne Diseases

- Overview of Biological Hazards and Foodborne Diseases *ECD Todd* 221
Overview of Chemical, Physical, and Other Significant Hazards *GG Moy and ECD Todd* 243
Overview of Emerging Food Technologies *ECD Todd* 253
Prevalence of Foodborne Diseases in Africa *L Anelich* 262
Prevalence of Foodborne Diseases in North America *P Sockett* 276
Prevalence of Foodborne Diseases in South East and Central Asia *R Dewanti-Hariyadi and D Gitapratwi* 287
Prevalence of Foodborne Diseases in Australia and New Zealand *MD Kirk and RJ Lake* 295
Prevalence of Foodborne Diseases in Europe *SJ O'Brien* 302
Prevalence of Foodborne Diseases in Western Pacific Region *H Toyofuku* 312
Foodborne Diseases and Vulnerable Groups *J Rocourt* 323
Foodborne Diseases in Travelers *R Steffen* 332

Bacteria

- Acinetobacter* *E Bergogne-Bérézin* 337
Aeromonas *AJ Rodriguez-Morales and DM Castañeda-Hernández* 342
Arcobacter *HI Atabay, JEL Corry, and C Ceylan* 344
Bacillus anthracis *L Baillie and TG Huwar* 348
Bacillus cereus and Other Pathogenic *Bacillus* Species *PE Granum, L Stenfors Arnesen, and C From* 356
Brucella *G Pappas* 364
Campylobacter *A Kvalsvig, MG Baker, A Sears, and N French* 369

<i>Clostridium botulinum</i>	MW Peck	381
<i>Clostridium perfringens</i>	S Robertson, J Li, and BA McClane	395
Toxicogenic <i>Corynebacteria</i>	AA Zasada	403
<i>Coxiella burnetii</i>	SJ Cutler	410
Shiga Toxin-Producing <i>Escherichia coli</i> and Other Pathogenic <i>Escherichia coli</i>	A Caprioli, S Morabito, and G Scavia	417
<i>Cronobacter (Enterobacter) sakazakii</i> and Other <i>Cronobacter</i> spp.	K Abdesselam and F Pagotto	424
Other Pathogenic Enterobacteriaceae – <i>Enterobacter</i> and Other Genera	S Cooney, S O'Brien, C Iversen, and S Fanning	433
<i>Francisella tularensis</i>	M Gyuranecz	442
<i>Helicobacter pylori</i>	E Bergogne-Bérézin	446
<i>Listeria monocytogenes</i>	R Magalhães, C Mena, V Ferreira, J Silva, G Almeida, P Gibbs, and P Teixeira	450
<i>Mycobacterium avium</i> ssp. <i>paratuberculosis</i>	ECD Todd	462
<i>Mycobacterium bovis</i>	AJ Rodriguez-Morales and DM Castañeda-Hernández	468
<i>Pasteurella multocida</i>	T Magyar and A Lax	476
<i>Plesiomonas shigelloides</i>	RE Levin	480
<i>Proteus</i>	Yong Wang and Xiaoling Pan	486
<i>Pseudomonas</i>	Z Hossain	490
<i>Salmonella</i> Non-Typhi	S Ethelberg, K Mølbak, and MH Josefsen	501
<i>Salmonella</i> Typhi and <i>Salmonella</i> Paratyphi	SP Luby	515
<i>Shigella</i>	MZ Zaghoul	523
<i>Staphylococcus aureus</i>	ECD Todd	530
<i>Streptococcus</i>	Z Hossain	535
<i>Vibrio cholerae</i>	T Ramamurthy and GB Nair	546
<i>Vibrio parahaemolyticus</i>	T Ramamurthy and GB Nair	555
<i>Vibrio vulnificus</i>	I Karunasagar	564
Other Vibrios	A Palit and GB Nair	570
<i>Yersinia enterocolitica</i> and <i>Yersinia pseudotuberculosis</i>	ECD Todd	574

VOLUME 2 Hazards and Diseases

Prions and Agents of TSEs

Bovine Spongiform Encephalopathy in Cattle	D Matthews	1
Creutzfeldt–Jakob Disease	RG Will	12

Protozoa

<i>Cryptosporidium</i> spp.	BR Dixon	18
<i>Cyclospora cayetanensis</i>	VA Cama and YR Ortega	23

<i>Entamoeba histolytica</i>	GL Nichols	31
<i>Giardia lamblia</i>	RD Adam	37
<i>Cystoisospora belli</i> (Syn. <i>Isospora belli</i>)	AJ Rodriguez-Morales and DM Castañeda-Hernández	45
<i>Sarcocystis</i>	YR Ortega and IM Sulaiman	49
<i>Toxoplasma gondii</i>	EM Hanafi, A Taylan Ozkan, and DD Bowman	54
Helminth-Cestode		
<i>Echinococcus granulosus</i> and <i>Echinococcus multilocularis</i>	PR Torgerson	63
<i>Taenia saginata</i> and <i>Taenia solium</i>	RME Parkhouse and LJS Harrison	70
Helminth-Nematode		
Anisakid Nematodes	AJ Lymbery and JA Walters	78
<i>Ascaris</i>	C Dold and CV Holland	83
<i>Capillaria hepatica</i> and <i>Capillaria philippinensis</i>	VY Belizario Jr and FIG Totañes	90
<i>Gnathostoma spinigerum</i>	P Dekumyoy, D Watthanakulpanich, and J Waikagul	94
<i>Haplorchis</i>	JH Clausen and D Murrell	99
<i>Trichinella spiralis</i> and Other <i>Trichinella</i> Species	HR Gamble	104
<i>Trichuris trichiura</i>	J Horton	111
Helminth-Trematode		
<i>Clonorchis sinensis</i>	S-J Hong	116
<i>Dicrocoelium dendriticum</i>	G Cringoli and L Rinaldi	124
<i>Diphyllbothrium</i>	J Dupouy-Camet and R Peduzzi	130
<i>Echinostoma</i>	R Toledo and B Fried	134
<i>Fasciola hepatica</i> and <i>Fasciola gigantica</i>	MB Rokni	140
<i>Fasciolopsis buski</i>	S Mas-Coma	146
<i>Heterophyes heterophyes</i>	J-Y Chai	158
<i>Metagonimus yokogawai</i>	J-Y Chai	164
<i>Opisthorchis viverrini</i> and <i>Opisthorchis felinus</i>	P Sithithaworn, R Andrews, SV Shekhovtsov, VA Mordvinov, and DP Furman	170
<i>Paragonimus westermani</i> and <i>Paragonimus</i> Species	Y Nawa, U Thaenkham, P Ngoc Doanh, and D Blair	179
Spirochetes		
<i>Leptospira</i>	AJ Rodriguez-Morales and DM Castañeda-Hernández	189
Viruses		
Hantavirus	PJ Padula	194
Hepatitis A Virus	A Rzezutka and N Cook	198

Hepatitis E Virus	<i>N Cook, F Martelli, WHM van der Poel, and Franco M Ruggeri</i>	205
Lassa Fever Virus	<i>O Ogbu</i>	208
Nipah Virus	<i>SP Luby</i>	214
Norovirus	<i>E Duizer and M Koopmans</i>	218

Organisms of Concern but not Foodborne or Confirmed Foodborne

Foot-and-Mouth Disease Virus	<i>C Carrillo</i>	227
Classical Swine Fever Virus	<i>C Carrillo</i>	232
Bolivian Hemorrhagic Fever Virus (Machupo Virus)	<i>AJ Rodriguez-Morales and DM Castañeda-Hernández</i>	237
African Swine Fever Virus	<i>C Carrillo</i>	241
Spoilage Microorganisms	<i>RA Benner Jr</i>	245

Natural Toxicants

Alkaloids	<i>C Crews</i>	251
Naturally Occurring Toxins of Plant Origin	<i>C Crews and D Clarke</i>	261
Mushrooms and Toadstools	<i>D Clarke and C Crews</i>	269
Tetrodotoxin	<i>K Campbell and S Haughey</i>	277

Mycotoxins

Mycotoxins – General	<i>Jl Pitt</i>	283
Aflatoxins	<i>Jl Pitt</i>	289
Deoxynivalenol and Other Trichothecenes	<i>Jl Pitt</i>	295
Fumonisin	<i>Jl Pitt</i>	299
Ochratoxin A	<i>Jl Pitt</i>	304
Patulin	<i>Jl Pitt</i>	310
Zearalenone	<i>Jl Pitt</i>	313

Environmental Contaminants

Dioxins, Furans, and Dioxin-like Polychlorinated Biphenyls	<i>M Rose</i>	315
Environmental Estrogens – Hazard Characterization	<i>PD Darbre</i>	323
Nitrate and Nitrite	<i>A Cockburn, CW Heppner, and JLCM Dorne</i>	332
Perchlorate	<i>CW Murray and PM Bolger</i>	337

Toxic Metals

Arsenic	<i>SS-H Tao and PM Bolger</i>	342
Cadmium	<i>Y Zang and PM Bolger</i>	346
Lead	<i>CD Carrington and PM Bolger</i>	349

Mercury	<i>K Hailemariam and PM Bolger</i>	352
Trace Metals – Chromium, Nickel, Copper, and Aluminum	<i>A Yalçin Tepe</i>	356

Processing Contaminants

Acrylamide	<i>K Skog and G Viklund</i>	363
Advanced Glycation End Products (AGEs)	<i>R Kent and J Uribarri</i>	371
Benzene	<i>A Becalski</i>	376
Biogenic Amines	<i>S Bover-Cid, ML Latorre-Moratalla, MT Veciana-Nogués, and MC Vidal-Carou</i>	381
Chloropropanols and Related Esters	<i>C Crews</i>	392
Furan	<i>C Crews</i>	399
Hydroxymethylfurfural	<i>V Gökmén and FJ Morales</i>	404
N-Nitrosamines	<i>C Crews</i>	409
Polycyclic Aromatic Hydrocarbons (PAHs)	<i>M Huang and TM Penning</i>	416

Hazards of Food Contact Material

Bisphenol A and Endocrine Disruption	<i>LN Vandenberg</i>	424
Food Packaging Contaminants	<i>J Muncke</i>	430
Phthalates	<i>RW Benson</i>	438
Nanotechnologies and Nanomaterials	<i>BG Priestly, A Bartholomaeus, and R Drew</i>	444

Food Additives

Food Additives – General	<i>LD Tomaska and S Brooke-Taylor</i>	449
Antioxidants	<i>C Schyvens</i>	455
Colorants	<i>J Abbey, B Fields, M O'Mullane, and LD Tomaska</i>	459
Flavors and Flavor Enhancers	<i>TE Kaitano</i>	466
Preservatives	<i>N Fletcher</i>	471
Natural Preservatives	<i>L Angiolillo, A Conte, and MA Del Nobile</i>	474
Sweeteners	<i>M O'Mullane, B Fields, and G Stanley</i>	477

VOLUME 3 Foods, Materials, Technologies and Risks**Pesticide Residues**

Conazoles	<i>M Tasheva</i>	1
Dithiocarbamates	<i>FM Rubino, EJ Mrema, and C Colosio</i>	5
Herbicides	<i>I Dewhurst</i>	11
Inorganic and Other Metal-Containing Compounds	<i>A Moretto</i>	15
Organophosphates and Carbamates	<i>A Moretto</i>	19

Organochlorines	<i>EJ Mrema, C Colosio, and FM Rubino</i>	23
Pyrethroids	<i>R Pfeil</i>	31
Veterinary Drugs Residues		
Veterinary Drugs – General	<i>SF Sundlof</i>	35
Antibacterials	<i>S Fanning, J Wang, and N Leonard</i>	39
Anthelmintics	<i>R Romero-González, A Garrido Frenich, and JL Martínez Vidal</i>	45
Anabolics	<i>M Smith</i>	55
Coccidiostats	<i>A Anadón and MR Martínez-Larrañaga</i>	63
Ectoparasiticides	<i>T de Waal and M Danaher</i>	76
Control of Helminths	<i>T de Waal and M Danaher</i>	81
Nutritional Hazards		
Micronutrients: Vitamins and Minerals	<i>A Cilla, V Zanirato, MT Rodriguez-Estrada, and G Garcia-Llatas</i>	86
Macronutrients: Essential Fatty Acids	<i>BA Wilson, RD Pollard, and DS Ferguson</i>	95
Other Significant Hazards		
Food Allergies and Intolerances	<i>SM Gendel</i>	103
Food-Related Choking	<i>B Altkorn, G Rider, X Chen, and D Stool</i>	110
Physical Hazards in Foods	<i>M Edwards</i>	117
Food Technologies		
Food Technologies		
Aseptic Packaging	<i>A Götz, AA Wani, H-C Langowski, and J Wunderlich</i>	124
Biopreservation	<i>F-K Lücke</i>	135
Chilling	<i>SJ James and C James</i>	140
Cleaning and Disinfection Technologies (Clean-In-Place, Clean-Out-of-Place)	<i>R Ryther</i>	149
Drying	<i>CL Law, HHH Chen, and AS Mujumdar</i>	156
Fermentation	<i>MJR Nout</i>	168
Food Irradiation	<i>J Farkas, DAE Ehlermann, and Cs Mohácsi-Farkas</i>	178
Freezing	<i>SJ James and C James</i>	187
High Pressure Processing	<i>MF Patterson</i>	196
Microwave Heating	<i>M Regier</i>	202
Nanotechnology and Food Safety	<i>VJ Morris</i>	208
Packaging	<i>AA Wani, P Singh, and H-C Langowski</i>	211
Pasteurization	<i>T Deák</i>	219

Pulsed Ultraviolet Radiation Processing	<i>MC Lagunas-Solar</i>	225
Pulsed Electric Field Technology	<i>H Jaeger, N Meneses, and D Knorr</i>	239
Sterilization	<i>T Deák</i>	245

Foods, Materials and Risks

Safety of Food and Beverages

Fruits and Vegetables	<i>D Drissner and U Zuercher</i>	253
Seafood	<i>A DePaola and H Toyofuku</i>	260
Meat and Meat Products	<i>JN Sofos</i>	268
Poultry and Eggs	<i>F Hilbert, P Paulsen, and FJM Smulders</i>	280
Milk and Dairy Products	<i>PJ Jooste, L Anelich, and Y Motarjemi</i>	285
Dairy Products: Cheese	<i>M Mühlemann</i>	297
Cereals and Derived Products	<i>RL Beverly</i>	309
Oils and Fats	<i>G van Duijn</i>	315
Spices and Seasonings	<i>J Farkas and Cs Mohácsi-Farkas</i>	324
Oilseeds and Legumes	<i>E Sedaghati and H Hokmabadi</i>	331
Nuts	<i>H Hokmabadi and E Sedaghati</i>	340
Water (Bottled Water, Drinking Water) and Ice	<i>T Stroheker, F Peladan, and M Paris</i>	349
Soft Drinks and Fruit Juices	<i>R Ryan</i>	360
Alcoholic Beverages	<i>R Ryan</i>	364
Coffee, Tea and Herbals, Cocoa and Derived Products	<i>RH Stadler, G Hughes, and O Guillaume-Gentil</i>	371
Packaging Material and Auxiliary Items	<i>G Buonocore, G Sico, and G Mensitieri</i>	384
Safety of Food in Vending Machines	<i>M Saltmarsh</i>	397
Promotional Material	<i>L Verzegnassi and F Chastellain</i>	402
Risks of Food Adulteration	<i>J Spink</i>	413
Safety of Organic Foods	<i>SU Fabiansson</i>	417
Safety Consideration in Developing Functional Foods	<i>SU Fabiansson</i>	422
Probiotics and Prebiotics	<i>FX Malcata, TS Granja Tavares, and A Hernández-Mendoza</i>	427
Safety of Probiotics and Prebiotics	<i>UK Svensson and J Håkansson</i>	441
Safety of Irradiated Foods	<i>DAE Ehlermann</i>	447
Safety of Genetically Modified Foods	<i>ECD Todd</i>	453
Safety of Regional Specialities – Korean Fermented Foods	<i>CH Lee and GI Lee</i>	462
Safety of Human Milk: Microbiological Aspects	<i>RM Lawrence and RA Lawrence</i>	470
Safety of Human Milk: Chemical Aspects	<i>GG Moy</i>	477
Halal Food Requirements	<i>MM Chaudry and MN Riaz</i>	486
Kosher Food Requirements	<i>JM Regenstein and CE Regenstein</i>	492

VOLUME 4 Food Safety Management

Food Safety Management

Public Health Measures

Modern Approach to Food Safety Management: An Overview	<i>Y Motarjemi</i>	1
Risk Governance	<i>M Dreyer and O Renn</i>	13
Challenges of Developing Countries in Management of Food Safety	<i>PO Lamuka</i>	20
Challenges of Industrialized Countries in Food Safety Management	<i>LM Crawford</i>	27
Fundamentals of Food Legislation	<i>D Jukes</i>	33
International Standards and Harmonization of Food Safety Legislation	<i>GG Moy and Y Motarjemi</i>	39
Food Inspections and Enforcement Systems	<i>CS DeWaal, D Plunkett, and C Roberts</i>	46
Alerts and Early Warning Systems	<i>HJP Marvin and GA Kleter</i>	50
Monitoring of Contaminants	<i>SJ Crossley and J Baines</i>	55
Assessment of Novel Foods and Ingredients	<i>SU Fabiansson</i>	62
Food Defense: Prevention of Sabotage and Bioterrorism	<i>M Hennessey and F Busta</i>	68
Evaluation of the Efficacy of National Food Control Programs	<i>WA Anderson, E O'Leary, D Cousins, R Evans, and A Reilly</i>	71
Surveillance of Foodborne Diseases	<i>RV Tauxe and JM Besser</i>	77
Foodborne Disease Outbreak Investigation	<i>J Rocourt</i>	89
Environmental Assessment in Outbreak Investigations	<i>CA Selman and JJ Guzewich</i>	98
Safe Use of Wastewater for Agricultural Production	<i>KO Medlicott and R Bos</i>	107
Food Control and Public Health Laboratories	<i>MFG Jermini</i>	115
Health Education, Information, and Risk Communication	<i>Y Motarjemi</i>	123
Management of Food Safety in Food Service Sector	<i>R Mitchell</i>	133
Food Safety in Hospitals and Other Healthcare Settings	<i>BM Lund and SJ O'Brien</i>	140

Food Safety Assurance Systems

Food Safety and Quality Management Systems	<i>DL Newslow</i>	149
Good Practices in Fisheries and Aquaculture	<i>L Ababouch</i>	159
Good Animal Husbandry Practice	<i>KN Bhilegaonkar, S Rawat, and RK Agarwal</i>	168
Building Design	<i>HLM Lelieveld</i>	174
Hygienic Design of Equipment	<i>AN Murray</i>	181
Infestation Management in Food Production Premises	<i>CH Bell</i>	189
Personal Hygiene and Employee Health	<i>ECD Todd</i>	201
Cleaning and Disinfection	<i>V Kakurinov</i>	211
Hazard Analysis and Critical Control Point System (HACCP): Principles and Practice	<i>CA Wallace</i>	226
Management of Biofilm Risk	<i>G Wirtanen, M Raulio, and S Salo</i>	240

Microbiological Testing, Sampling Plans, and Microbiological Criteria	<i>MH Zwietering, T Ross, and LGM Gorris</i>	244
Management of Allergens in Food Industry	<i>RWR Crevel and SA Cochrane</i>	254
Management of Supplier and Raw Material	<i>B Pourkomialian</i>	262
Documentation and Record Keeping	<i>RF Stier</i>	268
Labeling and Information for Consumers	<i>D McCrea</i>	276
Audits of Food Safety Management Systems	<i>Y Motarjemi and S Mortimore</i>	288
Quality Assurance and Good Laboratory Practice	<i>M Farrell-Evans and W Warren</i>	293
Investigation of Incidents in Industry	<i>P McClure</i>	301
Recall Systems and Disposal of Food	<i>P Overbosch and J Carter</i>	309
Tampering	<i>E Norman, G Coulam, and K Masters</i>	315
Essentials of Crisis Management	<i>Y Motarjemi</i>	322
Root Cause Analysis of Incidents	<i>Y Motarjemi and CA Wallace</i>	331
Food Safety and Ethics	<i>N Veflen Olsen and Y Motarjemi</i>	340
Institutions Involved in Food Safety		
FAO/WHO Codex Alimentarius Commission (CAC)	<i>T Heilandt, CA Mulholland, and M Younes</i>	345
Food and Agriculture Organization of the United Nations (FAO)	<i>E Boutrif</i>	354
World Health Organization (WHO)	<i>J Schlundt</i>	359
World Organisation for Animal Health (OIE)	<i>M Thibier and B Vallat</i>	365
Consumer Organizations	<i>E Groth</i>	369
National Industry Organizations – Case of UK Food and Drink Federation	<i>K Chinyama</i>	373
International Organization for Standardization (ISO)	<i>M Petro-Turza</i>	379
International Life Sciences Institute (ILSI)	<i>N van Belzen, E Hentges, J Chen, YB Yee, and S Harris</i>	384
FoodDrinkEurope	<i>B Kettlitz</i>	388
International Food Information Council (IFIC) and Other Food Information Organizations	<i>DB Schmidt and AP Benson</i>	391
International Union of Food Science and Technology (IUFoST)	<i>A Mortimer and K Buckle</i>	395
Trust in Animals and Food Safety (TAFS) Forum	<i>U Sperling</i>	399
Global Harmonization Initiative (GHI)	<i>H Lelieveld</i>	400
Abbreviation of Selected Organizations Involved in Food Safety		403
Index		405