

# Contents

List of Contributors.....	xxiii
Foreword.....	xxvii
Preface to the Third Edition.....	xxix

## **PART 1 PRINCIPLES**

### **CHAPTER 1 Disease Processes in Foodborne Illness ..... 3**

**S.L. TAYLOR**

<b>1.1</b> Classification of Disease Processes in Foodborne Illness.....	3
<b>1.2</b> Structure and Function of the Digestive Tract.....	3
1.2.1 Anatomy and Digestive Functions.....	3
1.2.2 Fluid Balance.....	6
1.2.3 Immune Functions.....	9
<b>1.3</b> Infections.....	11
1.3.1 Types of Agents Involved.....	12
1.3.2 Pathogenesis.....	12
1.3.3 Defense Mechanisms.....	16
<b>1.4</b> Intoxications.....	18
1.4.1 Types of Agents Involved.....	19
1.4.2 Pathogenesis.....	19
1.4.3 Defense Mechanisms.....	21
<b>1.5</b> Metabolic Food Disorders.....	23
1.5.1 Lactose Intolerance.....	23
1.5.2 Favism.....	23
<b>1.6</b> Allergy.....	24
1.6.1 Types of Agents Involved.....	24
1.6.2 Pathogenesis.....	25
1.6.3 Defense Mechanisms.....	27
1.6.4 Celiac Disease as a Possible Food Allergy.....	27
1.6.5 Treatment of Food Allergies.....	27
<b>1.7</b> Idiosyncratic Illness.....	28
1.7.1 Unproven Reactions.....	28
1.7.2 Proven Reactions.....	29
<b>1.8</b> Summary.....	29
Bibliography.....	30

## **CHAPTER 2 Epidemiology, Cost, and Risk Analysis of Foodborne Disease ..... 31**

**S. HOFFMANN AND E. SCALLAN**

<b>2.1</b>	Introduction.....	31
<b>2.2</b>	Foodborne Disease Epidemiology .....	32
2.2.1	Epidemiological Methods Used to Study Foodborne Disease.....	35
2.2.2	Estimating the Overall Incidence of Foodborne Disease.....	38
2.2.3	Attributing Illness to Specific Foods .....	41
<b>2.3</b>	Measuring the Societal Impact of Foodborne Disease .....	43
2.3.1	Monetary Measures .....	44
2.3.2	Nonmonetary Measures.....	47
2.3.3	Modeling Disease .....	50
2.3.4	Recent Burden Estimates.....	50
<b>2.4</b>	Foodborne Disease Risk Analysis.....	54
2.4.1	Risk Assessment .....	55
2.4.2	Risk Management and Communication .....	57
<b>2.5</b>	Future of Foodborne Disease and Disease Prevention .....	57
	Disclaimer .....	58
	Bibliography .....	58

## **CHAPTER 3 Routes of Transmission in the Food Chain ..... 65**

**R.A. STEIN AND M. CHIRILĂ**

<b>3.1</b>	Introduction.....	65
<b>3.2</b>	General Considerations About Routes of Transmission .....	66
<b>3.3</b>	Irrigation Water.....	67
<b>3.4</b>	Zoonotic Transmission.....	69
<b>3.5</b>	Foodborne Pathogens Transmitted Through Insects.....	71
<b>3.6</b>	The Food-Processing Environment.....	73
<b>3.7</b>	Cross-Contamination and Environmental Surfaces .....	77
<b>3.8</b>	Airborne Route and Fomites.....	81
<b>3.9</b>	Foodborne Pathogens With Multiple Transmission Vehicles/Routes.....	82
3.9.1	Botulism .....	82
3.9.2	Listeria.....	84
3.9.3	Noroviruses.....	85
<b>3.10</b>	Superspreading.....	86
<b>3.11</b>	Conclusions .....	88
	Bibliography .....	89

## **CHAPTER 4 Spread of Antibiotic Resistance in Food Animal Production Systems ..... 105**

**W.A. GEBREYES, T. WITTUM, G. HABING, W. ALALI, M. USUI AND S. SUZUKI**

4.1 Introduction.....	105
4.2 A Brief Overview of Mechanisms of Resistance.....	106
4.3 Antibiotic Resistance Among Pathogens on Dairy Farms.....	107
4.4 Differences in Antibiotic Resistance Between Organic and Conventional Dairy Farms .....	108
4.5 Beef Feedlots and Antibiotic Resistance .....	108
4.6 Antibiotic Use and Antibiotic Resistance in Poultry Production and Bird Species.....	110
4.7 Antibiotic Resistance in Swine Production Systems.....	111
4.8 Natural Aquatic Environment and Distribution of Resistance .....	112
4.9 Wild Animals and Distribution of Antibiotic Resistance.....	113
4.10 Fish and Their Role in the Spread of Antibiotic Resistance .....	117
4.11 Insects and Antibiotic Resistance.....	118
4.12 Critical Issues in Antimicrobial Resistance.....	118
4.13 Control of Antibiotic Resistance in the Food Chain .....	119
Bibliography .....	121

## **PART 2 PATHOGENS RESPONSIBLE FOR INFECTIOUS DISEASE**

### **CHAPTER 5 *Salmonella*..... 133**

**C. GRAZIANI, C. LOSASSO, I. LUZZI, A. RICCI, G. SCAVIA AND P. PASQUALI**

5.1 Overview.....	133
5.2 Nomenclature.....	134
5.3 Microbiological Characteristics.....	137
5.3.1 Virulence Genes.....	137
5.4 Host–Pathogen Interaction.....	139
5.5 Antimicrobial Resistance.....	142
5.6 Epidemiology and Surveillance.....	144
5.7 Risk Mitigation .....	149
5.7.1 Control Measures at the Farm Level .....	149
5.7.2 Feedstuff .....	150
5.7.3 Biosecurity.....	150
5.7.4 Vaccines.....	151
5.7.5 Other Measures.....	152

5.7.6 Transport.....	153
5.7.7 Hygienic Practices and Indicators .....	153
5.7.8 Decontaminants .....	153
5.7.9 Control Measures at Foodstuff Level .....	154
5.7.10 Predictive Microbiology .....	154
5.7.11 The Consumer Phase .....	155
Bibliography .....	155
<b>CHAPTER 6 <i>Shigella</i>.....</b>	<b>171</b>
<b>K. BLIVEN AND K.A. LAMPEL</b>	
6.1 Introduction.....	171
6.2 Taxonomy .....	173
6.3 Epidemiology.....	174
6.4 Transmission .....	175
6.5 Clinical Manifestations.....	175
6.6 Pathogenesis.....	176
6.6.1 Invasion.....	176
6.6.2 Intra- and Intercellular Spread.....	176
6.6.3 Host Innate Immune Manipulation.....	177
6.7 Detection.....	177
6.7.1 Detection of <i>Shigella</i> in Food.....	177
6.7.2 Bacteriological Methods.....	178
6.7.3 Nucleic Acid-Based Assays .....	179
6.7.4 Other Technologies.....	180
6.7.5 PulseNet.....	180
6.8 Treatment and Prevention .....	180
6.8.1 Antibiotic Treatment.....	180
6.8.2 Vaccines .....	181
6.9 Concluding Remarks .....	182
Bibliography .....	182
<b>CHAPTER 7 <i>Escherichia coli</i> as a Pathogen .....</b>	<b>189</b>
<b>J.L. SMITH AND P.M. FRATAMICO</b>	
7.1 Introduction.....	189
7.2 Enteropathogenic <i>E. coli</i> .....	189
7.2.1 Pathogenesis .....	189
7.2.2 Epidemiology .....	190
7.2.3 Detection of EPEC .....	191
7.3 Enteroaggregative <i>E. coli</i> .....	191
7.3.1 Pathogenesis .....	191
7.3.2 Virulence Factors.....	191

7.3.3 Epidemiology .....	192
7.3.4 Detection of EAEC .....	192
<b>7.4 Enterotoxigenic <i>E. coli</i> .....</b>	<b>192</b>
7.4.1 Disease.....	192
7.4.2 Pathogenicity .....	193
7.4.3 Detection of ETEC .....	193
<b>7.5 Shiga Toxin–Producing <i>E. coli</i> and Shiga Toxin–Producing Enteroaggregative <i>E. coli</i>.....</b>	<b>194</b>
7.5.1 Disease.....	194
7.5.2 Pathogenesis of STEC .....	194
7.5.3 Shiga Toxin.....	195
7.5.4 Transmission, Reservoirs, and Sources of STEC .....	196
7.5.5 Incidence of STEC .....	196
7.5.6 Acid Resistance of the STEC .....	199
7.5.7 Shiga Toxin–Producing Enteroaggregative <i>E. coli</i> .....	199
7.5.8 Detection of STEC and STEAEC.....	200
<b>7.6 Enteroinvasive <i>E. coli</i> .....</b>	<b>201</b>
7.6.1 Detection of EIEC .....	202
<b>7.7 Diffusely Adherent <i>E. coli</i> .....</b>	<b>202</b>
7.7.1 Detection of DAEC.....	202
<b>7.8 Adherent Invasive <i>E. coli</i> .....</b>	<b>202</b>
<b>7.9 Extraintestinal Pathogenic <i>E. coli</i>.....</b>	<b>203</b>
7.9.1 Uropathogenic <i>E. coli</i> .....	204
7.9.2 Neonatal Meningitis <i>E. coli</i> .....	205
7.9.3 Sepsis-Associated <i>E. coli</i> .....	206
7.9.4 Avian Pathogenic <i>E. coli</i> .....	206
<b>7.10 Detection of Pathogenic <i>E. coli</i>.....</b>	<b>206</b>
Bibliography .....	208

## **CHAPTER 8 *Campylobacter* Foodborne Disease ..... 209**

**I.F. CONNERTON AND P.L. CONNERTON**

<b>8.1 Introduction.....</b>	<b>209</b>
<b>8.2 Characteristics of Members of the Genus <i>Campylobacter</i> .....</b>	<b>209</b>
8.2.1 The Genus <i>Campylobacter</i> .....	209
8.2.2 <i>Campylobacter</i> Species .....	210
<b>8.3 Diseases Caused by <i>C. jejuni</i> and <i>C. coli</i> .....</b>	<b>210</b>
8.3.1 Onset and Symptoms.....	210
8.3.2 Complications.....	211
8.3.3 Antibiotics and Resistance .....	212
<b>8.4 Epidemiology.....</b>	<b>212</b>
<b>8.5 Pathogenesis.....</b>	<b>212</b>

8.6	Sources and Transmission.....	214
8.7	Viable-But-Nonculturable State.....	214
8.8	Isolation and Identification .....	215
8.8.1	Isolation .....	215
8.8.2	Detection and Quantification Without Isolation .....	216
8.8.3	Confirmatory Tests .....	216
8.8.4	Species Identification.....	217
8.8.5	Typing.....	217
8.9	Control Measures.....	217
8.9.1	On the Farm.....	217
8.9.2	During Processing and Retail .....	219
8.9.3	In the Kitchen .....	220
8.10	Genomics.....	220
8.11	Summary .....	221
	Bibliography .....	221
<b>CHAPTER 9</b>	<b><i>Yersinia enterocolitica</i>.....</b>	<b>223</b>
	<b>M. FREDRIKSSON-AHOMAA</b>	
9.1	Introduction.....	223
9.2	Characteristics.....	223
9.3	Yersiniosis.....	225
9.4	Reservoir .....	226
9.5	Prevalence in Food and Water.....	227
9.6	Transmission Routes.....	228
9.7	Isolation, Identification, and Characterization.....	228
9.8	Control and Prevention .....	230
	Bibliography .....	232
<b>CHAPTER 10</b>	<b><i>Clostridium perfringens</i>.....</b>	<b>235</b>
	<b>R.G. LABBE AND V.K. JUNEJA</b>	
10.1	Introduction .....	235
10.2	Characteristics of the Disease .....	235
10.3	Characteristics of the Organism .....	237
10.3.1	Vegetative Cells and Spores.....	237
10.3.2	The Enterotoxin .....	239
10.4	Transmission via Food .....	240
10.5	Isolation and Identification.....	240
10.6	Treatment and Prevention.....	241
	Bibliography .....	242

**CHAPTER 11 *Vibrio* ..... 243**

J.L. JONES

<b>11.1</b>	Introduction .....	243
<b>11.2</b>	<i>Vibrio cholerae</i> .....	243
	11.2.1 Background and Disease.....	243
	11.2.2 The Organism .....	244
	11.2.3 Transmission .....	245
	11.2.4 Laboratory Methods.....	246
	11.2.5 Prevention .....	246
<b>11.3</b>	<i>Vibrio parahaemolyticus</i> .....	247
	11.3.1 Background and Disease.....	247
	11.3.2 The Organism .....	247
	11.3.3 Transmission.....	248
	11.3.4 Laboratory Procedures.....	248
	11.3.5 Prevention .....	249
<b>11.4</b>	<i>Vibrio vulnificus</i> .....	249
	11.4.1 Disease.....	249
	11.4.2 The Organism .....	250
	11.4.3 Transmission.....	250
	11.4.4 Laboratory Procedure .....	251
	11.4.5 Prevention .....	251
<b>11.5</b>	Summary .....	251
	Bibliography.....	252

**CHAPTER 12 *Listeria monocytogenes* ..... 253**

C.E.D. REES, L. DOYLE AND C.M. TAYLOR

<b>12.1</b>	Introduction .....	253
<b>12.2</b>	<i>Listeria monocytogenes</i> .....	253
	12.2.1 Characteristics.....	253
	12.2.2 Taxonomy .....	255
	12.2.3 Subtyping of <i>L. monocytogenes</i> .....	255
	12.2.4 Reservoirs .....	256
<b>12.3</b>	Listeriosis .....	256
	12.3.1 Infectious Dose .....	256
	12.3.2 Incubation Period.....	257
	12.3.3 Symptoms .....	257
	12.3.4 Virulence Factors .....	259
<b>12.4</b>	Foodborne Transmission of <i>L. monocytogenes</i> .....	260
	12.4.1 Foodborne Outbreaks of Listeriosis.....	261
	12.4.2 Case Studies of Representative Outbreaks of Listeriosis.....	262

12.5	Control in Foods.....	264
12.5.1	Temperature .....	264
12.5.2	pH and Water Activity.....	265
12.5.3	Other Factors.....	265
12.5.4	Behavior in Foods.....	267
12.5.5	Control in the Food-Processing Environment.....	268
12.6	Regulatory Control.....	270
12.7	Isolation and Identification of <i>L. monocytogenes</i> .....	272
12.8	Summary .....	274
	Bibliography.....	274
<b>CHAPTER 13</b>	<b>Infrequent Microbial Infections .....</b>	<b>277</b>
	<b>C.E.R. DODD</b>	
13.1	Scope.....	277
13.2	Genus <i>Bacillus</i> in Foodborne Disease.....	277
13.2.1	<i>Bacillus anthracis</i> .....	277
13.2.2	<i>Bacillus subtilis</i> Group .....	278
13.3	<i>Cronobacter</i> .....	279
13.4	<i>Aeromonas</i> .....	282
13.5	<i>Plesiomonas shigelloides</i> .....	284
13.6	Potentially Foodborne Pathogens.....	285
13.6.1	<i>Clostridium difficile</i> .....	285
13.6.2	<i>Arcobacter</i> .....	286
13.6.3	<i>Mycobacterium paratuberculosis</i> .....	287
	Bibliography.....	287
<b>CHAPTER 14</b>	<b>Viruses .....</b>	<b>289</b>
	<b>M. KOOPMANS, A. BOSCH AND S. LE GUYADER</b>	
14.1	Introduction.....	289
14.1.1	History of Food Virology.....	289
14.1.2	Special Common Properties of Foodborne Viruses .....	290
14.2	Hepatitis A Virus and Hepatitis E Virus .....	291
14.2.1	Agent.....	291
14.2.2	Disease.....	291
14.2.3	Transmission.....	292
14.2.4	Noteworthy Outbreaks.....	292
14.2.5	Hepatitis E Virus .....	293
14.3	Norovirus.....	293
14.3.1	Agents.....	293
14.3.2	Disease.....	294



14.3.3	Transmission .....	294
14.3.4	Noteworthy Outbreaks .....	295
<b>14.4</b>	<b>Other Gastroenteritis Viruses .....</b>	<b>295</b>
14.4.1	Agents .....	295
14.4.2	Diseases .....	296
14.4.3	Transmission .....	297
14.4.4	Noteworthy Outbreaks .....	297
<b>14.5</b>	<b>Other Viruses and Food .....</b>	<b>297</b>
14.5.1	Tick-Borne Encephalitis Virus .....	297
14.5.2	Other Enteric Viruses That May Be Foodborne .....	297
<b>14.6</b>	<b>Detection and Monitoring .....</b>	<b>298</b>
14.6.1	Sampling and Sample Processing .....	298
14.6.2	Available Detection Methods .....	299
14.6.3	Prospects for Monitoring via Indicators .....	301
<b>14.7</b>	<b>Prevention .....</b>	<b>302</b>
14.7.1	Preventing Contamination of Foods .....	302
14.7.2	Inactivation of Foodborne Viruses .....	302
<b>14.8</b>	<b>Summary .....</b>	<b>302</b>
	Bibliography .....	303
<b>CHAPTER 15</b>	<b>Parasites .....</b>	<b>305</b>
	<b>F. BRUSCHI AND M.A. GÓMEZ-MORALES</b>	
<b>15.1</b>	<b>Introduction .....</b>	<b>305</b>
<b>15.2</b>	<b>Meatborne Parasites .....</b>	<b>305</b>
15.2.1	<i>Toxoplasma gondii</i> .....	305
15.2.2	<i>Sarcocystis</i> Species .....	308
15.2.3	<i>Trichinella</i> Species .....	309
15.2.4	<i>Taenia</i> Species .....	311
<b>15.3</b>	<b>Fishborne Parasites .....</b>	<b>313</b>
15.3.1	<i>Capillaria philippinensis</i> .....	313
15.3.2	<i>Gnathostoma</i> Species .....	313
15.3.3	Anisakidae Family .....	315
15.3.4	<i>Clonorchis sinensis</i> .....	316
15.3.5	<i>Opisthorchis viverrini</i> .....	316
15.3.6	Other Fishborne Flukes .....	317
15.3.7	<i>Diphyllbothrium latum</i> .....	318
<b>15.4</b>	<b>Parasites Transmitted by Freshwater-Raised Plants .....</b>	<b>319</b>
<b>15.5</b>	<b>Parasites Disseminated in Fecally Contaminated Food and Water .....</b>	<b>320</b>
15.5.1	<i>Cystoisospora belli</i> (Previously <i>Isospora belli</i> ) .....	320
15.5.2	<i>Cyclospora cayetanensis</i> .....	321

15.5.3 <i>Cryptosporidium</i> Species.....	321
15.5.4 <i>Giardia duodenalis</i> .....	322
15.5.5 Soil-Transmitted Nematodes and Visceral Larva Migrans.....	323
<b>15.6 Summary</b> .....	323
Bibliography.....	324

## **PART 3 INTOXICATIONS**

### **CHAPTER 16 Naturally Occurring Toxicants in Foods ..... 327**

**S.L. TAYLOR AND S.L. HEFLE**

<b>16.1</b> Introduction .....	327
<b>16.2</b> Natural Sources of Toxicants in Foods.....	327
16.2.1 Naturally Occurring Constituents of Food.....	327
16.2.2 Naturally Occurring Contaminants of Food .....	328
<b>16.3</b> The Preoccupation With Natural Foods .....	328
16.3.1 Definitions of “Natural” .....	328
16.3.2 Concerns Over Additives in Foods .....	328
16.3.3 Hazards Associated With Naturally Occurring Substances.....	330
<b>16.4</b> Intoxications From Naturally Occurring Toxicants.....	333
16.4.1 Statistics on Chemical Etiology of Foodborne Disease.....	334
16.4.2 Naturally Occurring Contaminants.....	335
<b>16.5</b> Summary .....	344
Bibliography.....	344

### **CHAPTER 17 Seafood Toxins..... 345**

**E.A. JOHNSON AND E.J. SCHANTZ**

<b>17.1</b> Introduction .....	345
<b>17.2</b> Overview of the Causes of Seafood Intoxications .....	346
<b>17.3</b> Incidence and Economic Costs of Seafood Intoxications .....	347
<b>17.4</b> Amnesic Shellfish Poisoning (Domoic Acid) .....	348
<b>17.5</b> Ciguatera Fish Poisoning .....	353
<b>17.6</b> Diarrhetic Shellfish Poisoning.....	354
<b>17.7</b> Azaspiracid Shellfish Poisoning.....	354
<b>17.8</b> Neurotoxic Shellfish Poisoning.....	354
<b>17.9</b> Paralytic Shellfish Poisoning.....	355
<b>17.10</b> Puffer Fish Poisoning .....	357
<b>17.11</b> <i>Pfiesteria</i> Toxins.....	357

17.12	Cyanobacterial Intoxications.....	358
17.13	Scombroid (Histamine) Fish Poisoning .....	360
17.14	Other Finfish and Shellfish Toxins .....	361
17.15	Assay of Seafood Toxins.....	362
17.16	Treatment and Prevention of Seafood Intoxications .....	362
17.17	Safety Precautions for Handling Toxic Seafoods and Algae....	363
17.18	Conclusions and Perspectives .....	363
	Bibliography .....	364
<b>CHAPTER 18</b>	<b>Staphylococcal Food Poisoning.....</b>	<b>367</b>
	<b>G.C. STEWART</b>	
18.1	Introduction .....	367
18.2	Characteristics of the Disease .....	368
18.3	Source of the Contamination.....	368
18.4	The Staphylococcal Enterotoxins.....	369
18.5	Genetics of Enterotoxin Production .....	370
18.6	Enterotoxin Expression .....	371
18.7	Outbreak Requirements.....	372
18.8	Enterotoxin Mode of Action.....	372
	18.8.1 Emesis.....	372
	18.8.2 Superantigenic/Pyrogenic Properties of Enterotoxins....	373
18.9	Detection .....	375
18.10	Prevention of Staphylococcal Food Poisoning.....	376
18.11	Vaccination Against SFP .....	377
	Bibliography .....	377
<b>CHAPTER 19</b>	<b>Botulism .....</b>	<b>381</b>
	<b>N.G. PARKINSON, E.A. JOHNSON AND K.A. ITO</b>	
19.1	Introduction .....	381
19.2	Characteristics of the Organism .....	381
19.3	Characteristics of the Disease .....	383
19.4	Transmission via Food .....	384
19.5	Isolation and Identification of the Organism and Its Toxin.....	385
	19.5.1 Sample Processing .....	386
	19.5.2 Culture Methods .....	386
	19.5.3 Toxin Detection.....	387
	19.5.4 Alternative Methods.....	388
19.6	Treatment and Prevention.....	388
	19.6.1 Illness and Treatment.....	388
	19.6.2 Prevention .....	389

19.6.3 Spore Destruction .....	389
19.6.4 Preventing Growth .....	391
<b>19.7 Infant Botulism.....</b>	<b>391</b>
<b>19.8 Therapeutic Applications .....</b>	<b>392</b>
<b>19.9 Summary .....</b>	<b>393</b>
Bibliography.....	393
<b>CHAPTER 20 <i>Bacillus cereus</i> Food Poisoning.....</b>	<b>395</b>
<b>M.W. GRIFFITHS AND H. SCHRAFT</b>	
<b>20.1 Introduction .....</b>	<b>395</b>
<b>20.2 Characteristics of the Organism .....</b>	<b>396</b>
20.2.1 The Spore.....	396
20.2.2 Vegetative Growth.....	397
<b>20.3 Characteristics of <i>Bacillus cereus</i> Food Poisoning.....</b>	<b>397</b>
20.3.1 Incidence of Illness .....	398
<b>20.4 Pathogenesis .....</b>	<b>398</b>
20.4.1 Diarrheal Syndrome.....	398
20.4.2 Emetic Syndrome.....	399
<b>20.5 Transmission via Food .....</b>	<b>400</b>
20.5.1 Diarrheal Syndrome .....	401
20.5.2 Emetic Syndrome.....	401
<b>20.6 Isolation and Identification.....</b>	<b>402</b>
20.6.1 Cultural Methods .....	402
20.6.2 Molecular Diagnostic and Typing Methods.....	402
20.6.3 Noncultural Detection Methods.....	403
20.6.4 Detection of Toxins.....	404
<b>20.7 Treatment and Prevention.....</b>	<b>404</b>
<b>20.8 Summary .....</b>	<b>404</b>
Bibliography.....	405
<b>CHAPTER 21 <i>Mycotoxins</i> .....</b>	<b>407</b>
<b>R.A. STEIN AND A.E. BULBOACĂ</b>	
<b>21.1 Introduction .....</b>	<b>407</b>
<b>21.2 Mycotoxins and Their Clinical Effects .....</b>	<b>408</b>
21.2.1 Aflatoxins.....	408
21.2.2 Fumonisin.....	414
21.2.3 Trichothecene Mycotoxins .....	417
21.2.4 Ochratoxins.....	420
21.2.5 Sterigmatocystin .....	422
21.2.6 Zearalenone.....	423

21.2.7 Ergot Alkaloids .....	425
21.2.8 Other Mycotoxins .....	426
<b>21.3 Mechanisms of Action of Mycotoxins .....</b>	<b>428</b>
<b>21.4 Control and Preventive Measures.....</b>	<b>430</b>
<b>21.5 Conclusion.....</b>	<b>432</b>
Bibliography.....	433
<b>CHAPTER 22 Chemical Intoxications .....</b>	<b>447</b>
<b>S.L. TAYLOR</b>	
<b>22.1 Introduction .....</b>	<b>447</b>
22.1.1 Incidence of Foodborne Disease Outbreaks of Chemical Etiology .....	447
22.1.2 Types of Chemicals Involved in Chemical Intoxications Associated With Foods.....	447
<b>22.2 Agricultural Chemical Residues .....</b>	<b>448</b>
22.2.1 Insecticides .....	448
22.2.2 Herbicides.....	450
22.2.3 Fungicides.....	451
22.2.4 Fertilizers .....	451
22.2.5 Feed Additives .....	452
22.2.6 Veterinary Drugs and Antibiotics.....	452
<b>22.3 Food Additives .....</b>	<b>452</b>
<b>22.4 Chemicals Migrating From Packing Materials .....</b>	<b>455</b>
<b>22.5 Chemicals Produced During Processing, Storage,     Preparation, and Handling of Foods.....</b>	<b>455</b>
<b>22.6 Inadvertent or Accidental Contaminants .....</b>	<b>456</b>
22.6.1 Industrial and/or Environmental Pollutants .....	456
22.6.2 Chemicals From Utensils.....	456
22.6.3 Accidental Contaminants.....	457
<b>22.7 Summary .....</b>	<b>458</b>
Bibliography.....	458
<b>CHAPTER 23 Diet and Cancer.....</b>	<b>459</b>
<b>E. GARCIA AND C.K. WINTER</b>	
<b>23.1 Introduction .....</b>	<b>459</b>
<b>23.2 Incidence of Major Cancers .....</b>	<b>459</b>
<b>23.3 Carcinogens in Food.....</b>	<b>462</b>
<b>23.4 Nutritional Factors and Cancer .....</b>	<b>464</b>
23.4.1 Caloric Intake.....	464
23.4.2 Fat .....	464

23.4.3 Protein.....	465
23.4.4 Dietary Fiber.....	465
23.4.5 Micronutrients.....	466
23.4.6 Alcohol.....	466
23.4.7 Coffee.....	466
<b>23.5</b> Dietary Protective Factors.....	466
<b>23.6</b> Conclusion.....	470
Bibliography.....	471

## **PART 4 FOOD SENSITIVITIES/INTOLERANCES**

### **CHAPTER 24 Celiac Disease ..... 475**

**R.A. STEIN AND D.E. KATZ**

<b>24.1</b> Introduction.....	475
<b>24.2</b> Pathogenesis.....	476
<b>24.3</b> Epidemiology.....	479
<b>24.4</b> Etiology.....	481
24.4.1 Gluten.....	481
24.4.2 Genetic Factors.....	482
24.4.3 Additional Factors.....	484
<b>24.5</b> Pathology.....	485
<b>24.6</b> Serology.....	487
<b>24.7</b> Clinical Signs and Symptoms.....	489
<b>24.8</b> Diagnosis.....	492
<b>24.9</b> Therapy.....	494
24.9.1 Gluten-Free Diet.....	494
24.9.2 Gluten Replacement.....	494
24.9.3 Gluten Removal.....	494
24.9.4 Gluten Modification.....	495
24.9.5 Enzymatic Treatment of the Flour.....	495
24.9.6 Accelerating Intestinal Healing.....	495
24.9.7 Oral Enzyme Supplementation: ALV003.....	496
24.9.8 Larazotide Acetate to Prevent Absorption of the Gliadin Peptides.....	496
24.9.9 Probiotics and Lactobacilli.....	497
24.9.10 Synthetic Polymers.....	498
24.9.11 tTG2 Inhibitors.....	498
24.9.12 Reducing Cytokine Production.....	499
24.9.13 Vaccines.....	499
<b>24.10</b> Prognosis.....	500

24.11 Nonceliac Gluten Sensitivity.....	501
24.12 Conclusions.....	502
Bibliography.....	503
<b>CHAPTER 25 Fish: Escolar and Oilfish.....</b>	<b>527</b>
<b>T. ALDSWORTH</b>	
25.1 Introduction.....	527
25.2 Pathology.....	527
25.3 Virulence Factors.....	528
25.4 Biology of Escolar and Oilfishes.....	529
25.5 Identification of Escolar and Oilfish.....	531
25.6 Case Study—A Conference-Associated Outbreak.....	531
25.7 Conclusions.....	532
Bibliography.....	532
Index.....	535