Contents

Pref	ace	
	Section I GENERAL CONSIDERATION AND BIOLOGICAL ASPECTS	
1.	Food Biotechnology: An Overview	3-24
	Introduction 3 Methods Used in Biotechnology 4 Food Production 9 Regulatory, Safety and Socio-Economic Considerations 19	
2.	Micro-Organims Associated with Food	25-41
	Introduction 25 Bacteria, Yeast and Molds 25 Primary Sources of Micro-Organisms Commonly Associated with Food 27 Factors Influencing Microbial Activity 28 Micro-Organisms Important in Food Industry 32 Importance of Bacteria in Food Industry 34 Importance of Yeasts in Foods 35 Applications of Micro-Organisms in Food Biotechnology 36	
3.	Applications and Impact of Biotechnology in Food Industry Introduction 42 Role of Biotechnology in Food Sector 42 Potential Areas in Food Processing for Biotechnological Applications 43 Impact of Biotechnology in Food Industry 51 Commercial Opportunities 54	42-55
4.	Biotechnology of Fermentation	56-76
	Introduction 56 Types of Fermentation 57 Recovery and Purification of Products 65 Factors Affecting Fermentation Economics 70 Fermentation and Product Recovery Costs 71 Process Assessment 75	

Section II GENETICALLY MODIFIED CROPS

5.	Feeding the World and Eradicating Hunger	79-94
	Introduction 79	
	Global Food Production and Hunger 80	
	Breeding and Genetically Modified Crops 82	
	Potential Benefits of Biotechnology 84	
	Potential Risks of Biotechnology 87	
	Environmental Risks 87	
	Concerns and Challenges: Delivering Benefits, Managing Risks	90
6.	Genetically Modified Crops	95-102
	Introduction 95	
	Applications of Transgenic Plants in Human Nutrition 96	
	Genetically Modified Crops 96	
	Genetically Modified Animals and Human Nutrition 99	
	Health Risk of Genetically Modified Organisms 100	
	GMOs are Inherently Unsafe 100	
	GM Diet Shows Toxic Reactions in the Digestive Tract 100	
	GM Diets Cause Liver Damage 100	
	GM Feed Animals had Higher Death Rates and Organ Damage	100
	Reproductive Failure and Infant Motality 101	
	GM Crops Trigger Immune Reactions and may Cause Allergies	101
	Safety Aspects of GMO Food 101	

Section III **BIOTECHNOLOGY OF PROBIOTICS AND FUNCTIONAL FOODS**

7. Probiotics in Food

Introduction 105 Features and Composition of Probiotics 106 Characteristics of a Good Probiotics 106 Factors Affecting Viability in Foods 108 Probiotic Product Specifications, Quality Assurance and Regulatory Issues 111 Recommendations 115 Guidelines for the Evaluation of Probiotics in Food 115 Safety Considerations 117

8. Health Benefits of Probiotics

Introduction 120 Guidelines for the Assessment of Probiotic Micro-Organisms 120 Health Benefits of Probiotics 121 Testing Methods for Establishing Health Benefits Conferred by Probiotic Micro-Organisms 130 Recommendations 133

9. Functional Foods

Introduction 134 Lifestyle, Diet and Physical Activity 135

105-119

120-133

	Assessment of Food Functionality 136 Role of Functional Foods Mental State and Performance 145 Delivering the Benefits 147 Communicating the Benefits 148 Future Perspectives 150	137
10.	Health Benefits of Functional Ingredients from Marine Bioresources	152-162
	Introduction 152 Possible Applications on Extractions and Isolation of Functional Ingredients 153 Pharmacological and Nutritional View of Marine Proteins and Lipids	154
	Section IV BIOTECHNOLOGY OF DAIRY AND MILK PRODUCTS	
11.	Milk and Dairy Products	165-180
	Introduction 165 Physical and Chemical Structure of Milk 166 Natural Components in Milk 166 Milk Processing Operations 167 Pasteurisation of Milk 172 Key Products in Dairy Industry 174	
12.	Genetically Modified Cheese	181-185
	Introduction 181 Genetic Modification 181 Genetically Modified Cheeses 182	
13.	Health Benefits of Milk and Functional Dairy Products	186-190
	Introduction 186 Milk and its Health Benefits 187 Functional Dairy Products 189 Section V BIOTECHNOLOGY OF MEAT, FISH AND POULTRY	
		100.001
14.	Biotechnology of Meat Introduction 193 Meat and Meat Products 194 Structure and Composition 195 Contamination, Preservation and Spoilage of Meats and Meat Products 196 Food Biotechnology of Meat and Fish Products 197 Tenderisation Process 198 Enzymatic Tenderisation 199 Apoptosis Theory 200	193-201

Preface xi

15. Biotechnology of Fish

Introduction 202 Structure and Composition 202 Contamination, Preservation and Spoilage of Fish and Other Seafoods 203 Genetically Engineered Fish 203 Fish Feed Biotechnology 204 Transgenic Fish 204 Genetically Engineered Fish and Seafood: Environmental Concerns 205 Environmental Concerns and Control Options 206 Possible Benefits and Disadvantages of Genetically Engineered Fish and Seafood 208 Future Applications of Biotechnology 208

16. Impact of Biotechnology on Poultry Nutrition

210-218

Introduction 210 Poultry Farm 210 Slaughtering and Processing of Meat 211 Impact of Biotechnology on Poultry Nutrition 213 Mechanisms of Action 214 Criteria for Selection of Probiotics in the Poultry Industry 216 Evaluating Probiotic Effects on Growth Performance 216 Evaluating Probiotic Effects on the Intestinal Microbiota and Intestinal Morphology 218

Section VI GENETICALLY MODIFIED FOODS

17.	Fruits and Vegetables Biotechnology	221-230
	Introduction 221	
	Direct and Indirect Benefits of Biotechnology 222	
	Consumer Benefits 223 Strategies for Commercialisation 224	
	Biotechnological Approaches to Improve Nutritional Quality and Shelf Life of Fruits and Vegetables 224	
	Future Prospects 229	
18.	Biotechnology of Mushrooms	231-240
	Introduction 231	
	Identification of Mushrooms 231 Contribution to Livelihoods 232	
	Nutritional Value of Mushrooms 233	
	Essentials of Mushroom Cultivation 234	
	Opportunities and Challenges 238	
19.	Genetically Modified Fruits	241-248
	Introduction 241	
	Apples 241 Citrus 242	
	Citrus 242	

Cherry 243 Guava 244 202-209

Apricots 245 Papaya 246 Egg Plant 247

20. Genetically Modified Vegetables

Introduction 249 Tomatoes 249 Soyabeans 252 Carrot 256 Potatoes 258

21. Genetically Modified Foods

Introduction 261 Issues Related to Potential Health Effects of Foods Derived from Genetically Modified Plants 262 Alimentary Tract as the First Target of GM Food Risk Assessment 263 Suggested Protocol for GM Crop/Food Health Risk Assessment 264 Differences in Nutritional Performance Useful for Diagnosis of Harm 266 Problems and Perspectives 267 GM DNA Safety Studies in the Gastrointestinal Tract 267 GM Safety Studies 268 Criticisms Against GM Foods 268 Regulation of GM Foods and Role of Government 270 Labelling of GM foods 271 Most Common Genetically Modified Foods 273 Pros and Cons of Genetically Modified Foods 274 Advantages of GM foods 275

Section VII

PRODUCTION, PURIFICATION AND APPLICATION OF ENZYMES IN FOOD INDUSTRY

Microbial Enzymes, Production, Purification and Isolation	279-294
Introduction 279	
Enzyme Source 282	
Purification of Enzymes 283	
Formulation of the Final Enzyme Product 288	
Enzyme Recovery 291	
Future of Industrial Enzymes 293	
Applications of Enzymes in Food Industry	295-320
Introduction 295	
Sources of Enzymes 295	
Mechanism of Enzymes 296	
Functions of Enzymes 296	
Immobilised 297	
Amylases 298	
Pectic Enzymes 302	
Lactase Enzyme 306	
Invertase 307	

249-260

261-276

Lipase 312 Oxidoreductase 318 Peroxidase 318 Lactoperoxidase 318 Catalase 319 Sulphydryl Oxidase 319 Glucose Oxidase 320 Pyranose Oxidase 320 Xanthine Oxidase 320 Lipoxygenase 320 Dehydrogenase 320

Section VIII BREWING OF YEAST, BEER AND WINE INDUSTRY

24.	Yeast as a Versatile Tool in Biotechnology	323-336
	Introduction 323 Yeasts—Commercial Applications 323 Yeasts as Whole-Cell Biocatalysts 327 Yeast's Enzymes Applications 329 Yeast's Applications in Molecular Biology 332	
25.	Biotechnology of Brewer's Yeast	337-343
	Introduction 337 Biotechnology of Brewer's Yeast 337 Genetic Constitution of Brewer's Yeast 337	
26.	Biotechnology of Beer and Wine Industry	344-379
	Introduction 344 Overview of Malting and Brewing 345 Enzymes in Brewing 358 Wine 363 Brewery Waste Treatment Methods 370 Genetically Modified Organisms in the Wine Industry 375	
	Section IX ENVIRONMENTAL AND ECOLOGICAL ASPECTS OF FOOD BIOTECHNOI	.OGY
27.	Carbon Footprint of Food Industry	383-395
	Introduction 383 Ecological Footprint of the Global Food System 383 Eating Less Beef will Reduce Carbon Footprint More Than Cars 385 Shrink Your Food Footprint 386 Food Transportation Issues and Reducing Carbon Footprint 389 Carbon Footprint Ranking of Food 394	
28.	Utilisation of Food Wastes for Sustainable Development	396-417
	Introduction 396 Analysis of Fruit Processing and Evaluation of Waste Minimisation Potential 396	

Juice Concentration with Membranes 398 SFE for Recovery of Valuable Compounds from Solid Waste 399 Recycling of Fruit and Vegetables 400 Utilisation of Food Wastes for Sustainable Development 401 Waste to Enzymes Through Solid-State Fermentation 415

29. Environmental and Ecological Aspects of Genetically Modified Crops 418-426

Introduction 418 Risk Assessment Process 419 Problem Formulation for Environmental Risk Assessment 420 Ecological Benefits of GM Crop Cultivation 422 Pesticide Reductions Due to Insect Resistant *Bt*-Crops 423 Scientific Debates on Risks of GM Crops 425

Section X BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS

30. Bioethics and Biotechnology

429-451

Introduction 429 Goals of Biotechnology 430 Ethical Aspects of Food and Agricultural Biotechnology 433 Variety of Changes Shaping Bioethics Today 436 Safety of Food Biotechnology 437 Modern Food Biotechnology: Definition and Overview of Potential Benefits and Risks 437 Current Use, Research and Impending Development of Foods Produced through Modern Biotechnology 438 Developing Regulatory and Safety Systems for Modern Food Biotechnology: A Role for Capacity Building 447 Social and Ethical Concerns About GM Foods 450

31. Food Security and Intellectual Property Rights in Developing Countries 452-470

Introduction 452
Intellectual Property Rights in Developing Countries 453
International Law and Food Security 457
IPRs and Food Security—General Trends and Implementation 465
Food Security and Intellectual Property Rights in the South: Lessons from Recent Developments in India 465
Towards Sui Generis Intellectual Property Protection 469

Glossary	471–478
References	479–480
Index	481–490