

# Contents

Preface	xii
What Is Biotechnology?	xiii
What Is Food Biotechnology?	xvii
<b>Part I New Trends and Tools of Food Biotechnology</b>	<b>1</b>
<b>1 Fundamentals and New Aspects</b>	<b>3</b>
1.1 Biotechnological applications of animals, plants, and microbes	3
1.2 Cellular organization and membrane structure	6
1.3 Bacterial growth and fermentation tools	11
1.3.1 Classification and reproduction of biotechnologically important bacterial system	11
1.3.2 Bacterial growth	12
1.3.3 Environmental factors affecting bacterial growth	16
1.4 Fungal growth and fermentation tools	19
1.5 Classical strain improvement and tools	22
1.5.1 Natural selection and mutation	22
1.5.2 Recombination	27
Summary	30
1.6 Systems/synthetic biology and metabolic engineering	31
Summary	36
1.7 Bioengineering and scale-up process	36
1.7.1 Microbial and process engineering factors affecting performance and economics	38
1.7.2 Fermentor and bioreactor systems	39
1.7.3 Mass transfer concept	50
1.7.4 Heat transfer concept	53
1.7.5 Mass and heat transfer practice	57
1.7.6 Scale-up and scale-down of fermentations	71
1.7.7 Scale-up challenges	81
Summary	84
1.8 Molecular thermodynamics for biotechnology	85
1.8.1 Protein folding and stability	85
Summary	92
1.8.2 Downstream processes on crystallization and chromatography	93
Summary	96
1.9 Protein and enzyme engineering	96
Summary	100
1.10 Genomics, proteomics, and bioinformatics	100
Summary	108

1.11 Biosensors and nanobiotechnology	109
1.11.1 Biosensor	109
1.11.2 Nanobiotechnology and nanobiosensor	113
Summary	116
1.12 Quorum sensing and quenching	116
Summary	120
1.13 Micro- and nano-encapsulations	120
1.13.1 Microencapsulation	122
1.13.2 Nanoencapsulation	129
Summary	138
Bibliography	140
<b>2 Concepts and Tools for Recombinant DNA Technology</b>	<b>147</b>
2.1 Concepts of macromolecules: function and synthesis	147
2.1.1 DNA replication	147
2.1.2 Roles of RNA	150
2.1.3 Detailed aspects of protein synthesis	153
2.2 Concepts of recombinant DNA technology	161
2.2.1 Restriction endonucleases	162
2.2.2 Plasmid vectors	164
2.2.3 Purpose of gene cloning	168
2.3 DNA sequencing	180
2.4 Polymerase chain reaction (PCR)	180
2.5 Manipulation techniques of DNA	183
2.5.1 Isolation and purification of nucleic acids	183
2.5.2 Agarose gel electrophoresis	184
2.5.3 Blotting and hybridization	185
2.6 Gene cloning and production of recombinant proteins	186
2.6.1 Cloning and expression of bacterial $\beta$ -galactosidase in <i>E. coli</i>	186
2.6.2 Cloning, expression, and production of bovine chymosin (rennet) in yeast <i>K. lactis</i>	188
Summary	190
Bibliography	191
<b>Part I Questions and Answers</b>	<b>193</b>
<b>Part II Applications of Biotechnology to Food Products</b>	<b>205</b>
<b>3 Yeast-Based Processes and Products</b>	<b>207</b>
3.1 Food yeasts and derivatives	207
3.1.1 Introduction	207
3.1.2 Industrial processes	207
Summary	212
3.2 Alcoholic beverages	212
3.2.1 Introduction	212
3.2.2 Production and sales of major alcoholic beverages	212
3.2.3 Production processes	213
Summary	225
3.3 Industrial alcohols	225
3.3.1 Introduction	225
3.3.2 Raw materials and microorganisms	226
3.3.3 Production processes	230
3.3.4 Economics	231
Summary	232
3.4 Bread and related products	232
3.4.1 Introduction	232

3.4.2	Ingredients and formulations	233
3.4.3	Production processes	234
3.4.4	New developments	236
Summary		237
Bibliography		237
<b>4</b>	<b>Bacteria-Based Processes and Products</b>	<b>241</b>
4.1	Dairy products	241
4.1.1	Introduction	241
4.1.2	Basic knowledge of manufacture of dairy products	244
4.1.3	Metabolic systems in lactic acid bacteria	249
4.1.4	Genetic modification of lactic acid bacteria	252
4.1.5	Applications of genetic engineering	254
Summary		262
4.2	Meat and fish products	262
4.2.1	Introduction	262
4.2.2	Fermented meat products	263
4.2.3	New developments	267
4.2.4	Fermented fish products	267
Summary		270
4.3	Vegetable products	270
4.3.1	Introduction	270
4.3.2	Fermented vegetable products	271
4.3.3	Fermented soy products	275
4.3.4	New developments	280
Summary		280
4.4	Vinegar and other organic acids	281
4.4.1	Introduction	281
4.4.2	Acetic acid	281
4.4.3	Citric acid	283
4.4.4	Lactic acid	284
4.4.5	Malic acid	285
4.4.6	Fumaric acid	286
Summary		286
4.5	Bacterial biomass	287
4.5.1	Introduction	287
4.5.2	Microorganisms for the production of biomass	288
4.5.3	Raw materials for the production of biomass	289
4.5.4	Production process	292
4.5.5	Nutritional aspects	293
4.5.6	Economics and new developments	294
Summary		295
4.6	Polysaccharides	296
4.6.1	Introduction	296
4.6.2	Microbial polysaccharides	297
4.6.3	Fermentation process	298
4.6.4	Bacterial polysaccharides	299
4.6.5	Other polysaccharides	304
Summary		304
Bibliography		306
<b>5</b>	<b>Other Organism-Based Processes and Products</b>	<b>313</b>
5.1	Enzymes	313
5.1.1	Introduction	313
5.1.2	Production of enzymes	315
5.1.3	Applications	317

5.1.4	New developments and protein engineering	326
5.1.5	Economics	328
	Summary	328
5.2	Sweeteners	329
5.2.1	Introduction	329
5.2.2	Nutritive sweeteners	329
5.2.3	High-intensity sweeteners	333
5.2.4	Low calorie sweeteners	337
5.2.5	New developments	338
	Summary	339
5.3	Flavors and amino acids	339
5.3.1	Introduction	339
5.3.2	Microbial flavors	340
5.3.3	Enzymatic flavor generation	347
5.3.4	Amino acids	348
5.3.5	Economics	350
	Summary	351
5.4	Vitamins and pigments	352
5.4.1	Introduction	352
5.4.2	Production of vitamins	352
5.4.3	Production of pigments	356
5.4.4	Economics	359
	Summary	359
5.5	Mushrooms	360
5.5.1	Introduction	360
5.5.2	Cultivation	361
5.5.3	Culture preservation	363
	Summary	363
5.6	Cocoa, tea, and coffee fermentation	364
5.6.1	Introduction	364
5.6.2	Cocoa fermentation	364
5.6.3	Coffee fermentation	367
5.6.4	Tea fermentation	369
	Summary	372
5.7	Bacteriocins	372
5.7.1	Introduction	372
5.7.2	Classification	373
5.7.3	Mode of action	375
5.7.4	Bioengineering of bacteriocins	376
5.7.5	Applications of bacteriocins	379
5.7.6	Commercial production of bacteriocins	382
	Summary	383
5.8	Functional foods and nutraceuticals	383
5.8.1	Probiotics and prebiotics	384
5.8.2	Health claim regulation	396
	Summary	397
	Bibliography	397
	<b>Part II Questions and Answers</b>	<b>411</b>
	<b>Part III Other Potential Applications of the New Technology</b>	<b>431</b>
	<b>6 Plant Biotechnology, Animal Biotechnology, and Safety Assessment</b>	<b>433</b>
6.1	Plant biotechnology	433
6.1.1	Introduction	433
6.1.2	Plant cell and tissue cultivation	435

---

6.1.3	Plant breeding	437
6.1.4	Application of plant cell and tissue culture	441
	Summary	448
6.2	Animal biotechnology	449
6.2.1	Introduction	449
6.2.2	Transgenic animals	449
6.2.3	Animal cell culture	453
	Summary	463
6.3	Food safety issues of new biotechnologies	464
6.3.1	Introduction	464
6.3.2	Safety evaluation of novel food products	465
6.3.3	Genetically modified microorganisms and their products	467
6.3.4	Genetically modified plants and their products	469
6.3.5	Genetically modified animals and their products	473
6.3.6	Detection methods of GM crops	475
6.3.7	Detection methods of transgenic animals and fish	480
6.3.8	Containment: physical and biological	481
6.3.9	Promises and limitations	481
	Summary	482
	Bibliography	483
	<b>Part III Questions and Answers</b>	<b>491</b>
	<b>Index</b>	<b>497</b>