

---

## Contents

<i>Preface</i>	<i>page xi</i>
<hr/>	
<b>Chapter 1</b>   The nature of biotechnology	1
1.1 Introduction	1
1.2 What is biotechnology?	2
1.3 Biotechnology: an interdisciplinary pursuit	6
1.4 Biotechnology: a three-component central core	13
1.5 Product safety	15
1.6 Public perception of biotechnology	17
1.7 Biotechnology and the developing world	17
<hr/>	
<b>Chapter 2</b>   Biomass: a biotechnology substrate?	19
2.1 A biomass strategy	19
2.2 Natural raw materials	21
2.3 Availability of by-products	23
2.4 Raw materials and the future of biotechnology	25
<hr/>	
<b>Chapter 3</b>   Genetics and biotechnology	29
3.1 Introduction	29
3.2 Industrial genetics	31
3.3 Protoplast and cell fusion technologies	32
3.4 Genetic engineering	35
3.5 The polymerase chain reaction and DNA sequencing	41
3.6 Nucleic acid probes	43
3.7 Genomics and proteomics	44
3.8 Antisense and RNA interference	45
3.9 Systems biology	47
3.10 Potential laboratory biohazards of genetic engineering	47
<hr/>	
<b>Chapter 4</b>   Bioprocess/fermentation technology	49
4.1 Introduction	49
4.2 Principles of microbial growth	53
4.3 The bioreactor	57
4.4 Scale-up	63
4.5 Media design for fermentation processes	63
4.6 Solid substrate fermentation	65
4.7 Technology of mammalian and plant cell culture	67
4.8 Metabolic engineering	70
4.9 Downstream processing	71

<b>Chapter 5</b>	<b>Enzyme technology</b>	73
5.1	The nature of enzymes	73
5.2	The application of enzymes	75
5.3	Selection and development of producer strains for enzyme production	81
5.4	The technology of enzyme production	84
5.5	Immobilised enzymes	88
<b>Chapter 6</b>	<b>Biological fuel generation</b>	95
6.1	Global warming and the significance of fossil fuels	95
6.2	Photosynthesis: the ultimate energy source	96
6.3	Biofuels from biomass	97
6.4	Bioethanol from biomass	99
6.5	Biodiesel	103
6.6	Methane	104
6.7	Hydrogen	107
6.8	The way ahead for biofuels	108
6.9	Contrasting views on climate change	109
<b>Chapter 7</b>	<b>Environmental biotechnology</b>	110
7.1	Introduction	110
7.2	Microbial ecology/environmental biotechnology	112
7.3	Waste water and sewage treatment	113
7.4	Landfill technologies	118
7.5	Composting	119
7.6	Bioremediation	122
7.7	Detection and monitoring of pollutants	126
7.8	Microbes and the geological environment	126
7.9	Environmental sustainability and clean technology	130
<b>Chapter 8</b>	<b>Plant and forest biotechnology</b>	133
8.1	Introduction	133
8.2	Plant biotechnology	134
8.3	Forest biotechnology	146
<b>Chapter 9</b>	<b>Animal and insect biotechnology</b>	149
9.1	Introduction	149
9.2	Genetic manipulation and transgenic animals	150
9.3	Genetically engineered hormones and vaccines	154
9.4	Animal organs for human patients	156
9.5	Genetically modified insects	157
9.6	A look to the future	157
9.7	Diagnostics in plant and animal agriculture	158

<b>Chapter 10</b>	<b>Food and beverage biotechnology</b>	161
10.1	Introduction	161
10.2	Food and beverage fermentations	164
10.3	Microorganisms as food	178
10.4	Enzymes and food processing	185
10.5	Amino acids, vitamins and sweeteners	186
10.6	Organic acids and polysaccharides	188
10.7	Rapid diagnostics	188
10.8	Bioprocess technology	189
10.9	Public acceptance and safety of new biotechnology foods	189
<b>Chapter 11</b>	<b>Biotechnology and medicine</b>	190
11.1	Introduction	190
11.2	Pharmaceuticals and biopharmaceuticals	192
11.3	Antibiotics	193
11.4	Vaccines and monoclonal antibodies	196
11.5	Biopharmaceuticals/therapeutic proteins	201
11.6	Pharmacogenetics	205
11.7	Molecular biology and human disease	206
11.8	Diagnostics in developing countries	206
11.9	Gene therapy	207
11.10	Systems biology and medicine	209
<b>Chapter 12</b>	<b>Stem cell biotechnology</b>	211
12.1	The nature of stem cells	211
12.2	Stem cell cultivation	213
12.3	Human–animal embryos	215
12.4	Commercial potential for stem cell therapies	216
<b>Chapter 13</b>	<b>Protection of biotechnological inventions</b>	218
13.1	Introduction	218
13.2	Patent protection	219
13.3	Trade secrets	222
13.4	Plant breeders' rights	223
<b>Chapter 14</b>	<b>Safety in biotechnology</b>	224
14.1	Introduction	224
14.2	Concepts of hazard and risk	224
14.3	Problems of organism pathogenicity	225
14.4	Problems of biologically active biotechnology products	227
14.5	Biowarfare and bioterrorism	228

<b>Chapter 15</b>	<b>Public perception of biotechnology: genetic engineering – safety, social, moral and ethical considerations</b>	232
15.1	Introduction	232
15.2	Release of genetically manipulated organisms into the environment	234
15.3	Genetic modification and food uses	236
15.4	The applications of human genetic research	242
<b>Chapter 16</b>	<b>Looking to the future</b>	245
	<i>Glossary</i>	250
	<i>Further reading</i>	254
	<i>Index</i>	263