

Contents

List of contributing authors — XI

Shreya Gupta, Swati Sharma, Ashok Kumar Nadda and Shikha Chauhan

1 Biopolymer conjugates: an introduction — 1

- 1.1 Introduction — 1
- 1.2 Biopolymers — 3
 - 1.2.1 Sources of biopolymers — 3
 - 1.2.2 Types of biopolymers — 4
- 1.3 Polysaccharide conjugates — 4
- 1.4 Protein conjugates — 7
- 1.5 Metallo biopolymers — 8
- 1.6 Conclusions — 9
- References — 9

Witta Kartika Restu, Muhammad Ghozali, Evi Triwulandari, Yulianti Sampora, Melati Septiyanti, Yenny Meliana, Sun Theo C. L. Ndruru, Muhammad Ihsan Sofyan, Nanang Masruchin and Anita Marlina

2 Biopolymeric conjugation with thermoplastics and applications — 15

- 2.1 Introduction — 15
- 2.2 Polysaccharide-based biopolymer — 16
 - 2.2.1 Starch-based biopolymeric conjugation with thermoplastic — 16
 - 2.2.2 Chitosan-based biopolymeric conjugation with thermoplastic — 22
 - 2.2.3 Caragenan-based biopolymeric conjugation with thermoplastic — 26
 - 2.2.4 Alginate-based biopolymeric conjugation with thermoplastic — 29
- 2.3 Protein-based biopolymer — 32
 - 2.3.1 Keratin-based biopolymeric conjugation with thermoplastic — 32
 - 2.3.2 Collagen-based biopolymeric conjugation with thermoplastic — 35
 - 2.3.3 Gelatin-based biopolymeric conjugation with thermoplastic — 39
- 2.4 Lignocellulose-based biopolymer — 42
 - 2.4.1 Cellulose-based biopolymeric conjugation with thermoplastic — 42
 - 2.4.2 Lignin-based biopolymeric conjugation with thermoplastic — 45
 - 2.4.3 Tannin-based biopolymeric conjugation with thermoplastic — 48
- 2.5 The degradation of biopolymer conjugation thermoplastic — 54
- 2.6 Conclusions — 56
- References — 57

3	Biopolymeric conjugation with synthetic fibers and applications — 65
3.1	Introduction — 66
3.2	Various kinds of synthetic fibers — 67
3.2.1	Aramid or Kevlar fibers — 67
3.2.2	Carbon fibers — 68
3.2.3	Glass fibers — 69
3.2.4	Boron fibers — 71
3.2.5	Ceramic fibers — 71
3.2.6	Metallic fiber — 72
3.2.7	Polypropylene (PP) fibers — 72
3.2.8	Polyester (Polyethylene terephthalate) fibers — 73
3.2.9	Polyethylene (PE) fibers — 73
3.2.10	Polyvinyl alcohol (PVA) fibers — 74
3.3	Biocomposite of aramid fiber reinforced with biopolymer matrix — 74
3.3.1	Composite of aramid fiber reinforced with bagasse-epoxy matrix — 75
3.3.2	Natural fiber reinforced with polypropylene biocomposites — 76
3.3.3	Carbon fiber reinforced biopolymer composite — 76
3.3.4	Glass fiber reinforces biocomposite — 79
3.3.5	Aramid fiber reinforced biocomposite materials — 79
3.4	Conclusions — 83
	References — 84

Hardeep Kaur, Shinar Athwal, Neelam Negi, Aditya Nautiyal and Shanu Magotra

4	Biopolymeric conjugation with polynucleotides and applications — 89
4.1	Introduction — 89
4.2	Various polynucleotide conjugation systems — 91
4.2.1	Chitosan–polynucleotides conjugates — 91
4.2.2	Gelatin–polynucleotide conjugates — 92
4.2.3	Hyaluronic acid–polypeptide conjugates — 96
4.2.4	Cyclodextrin–polynucleotide conjugates — 97
4.2.5	Peptide–polynucleotide conjugates — 97
4.2.6	Phenanthridinium–polynucleotide conjugates — 98
4.2.7	Metallocene–polynucleotide conjugates — 99
4.2.8	Comparative review of the discussed biopolymer–polypeptide conjugate system — 100
4.2.9	Peptide coupling — 101
4.2.10	Reductive amination — 101
4.2.11	Acylation reaction — 101
4.2.12	Layer-by-layer (LbL) — 102
4.2.13	Garratt–Braverman cyclization (GBC) pathway — 103

4.2.14	Click chemistry —	103
4.2.15	Sonogashira cross-coupling —	103
4.3	Integration of nanoscience and polynucleotide-conjugated biopolymers —	104
4.4	A specific insight into RNA-based conjugation platforms —	105
4.4.1	RNA and conjugates unit —	105
4.4.2	RNA and therapeutics —	106
4.5	Essential utility of developed polynucleotide conjugated systems in various fields —	107
4.5.1	Biomedical field —	107
4.5.2	Industrial field —	112
4.6	Laboratory to commercial applicability —	114
4.7	Conclusion and prospect —	114
	References —	115

Amandeep Singh, Kamlesh Kumari and Patit Paban Kundu

5 Synthesis of biopolymer-polypeptide conjugates and their potential therapeutic interests — 121

5.1	Introduction —	121
5.2	Synthesis of biopolymer-polypeptide conjugates —	122
5.2.1	Peptide conjugation by polymerization —	123
5.2.2	Peptide conjugation by coupling —	123
5.3	Therapeutic significances of BPCs —	124
5.4	Conclusions —	136
5.5	Challenges and future perspectives —	136
	References —	136

Sriparna Ray

6 Biopolymeric conjugation with metals and their applications — 139

6.1	Introduction —	139
6.2	Chitosan-based metal biopolymer conjugates —	140
6.3	Cellulose-based metal biopolymer conjugates —	147
6.4	Starch-based metal biopolymer conjugates —	149
6.5	Conclusion and future scope —	150
	References —	150

Anchal Rana, Sonal Bhardwaj and Nandita Sharma

7 Biopolymer conjugation with phytochemicals and applications — 155

7.1	Introduction —	156
7.1.1	Phytochemicals —	157
7.1.2	Health benefits of phytochemicals —	158

7.1.3	Challenges to applications of phytochemicals —	159
7.1.4	Construction of phytochemical delivery systems using biopolymers —	160
7.1.5	Industrial applications of biopolymers —	163
7.2	Conclusions —	168
	References —	168

Gurleen Kaur, Babita Thakur, Ruth Gill, Rajinder Kaur and Sukhminderjit Kaur

8	Biopolymeric conjugation with food additives —	173
8.1	Introduction —	173
8.2	Biopolymers: their structure and source —	174
8.2.1	Chitosan —	175
8.2.2	Cellulose —	176
8.2.3	Alginate —	177
8.2.4	Starch —	178
8.3	Food additives —	178
8.3.1	Anti-caking agents —	179
8.3.2	Antioxidants —	180
8.3.3	Emulsifiers —	180
8.3.4	Antimicrobial agents —	180
8.3.5	Coloring agents —	181
8.3.6	Antifoaming agents —	181
8.3.7	Flavors/flavor enhancers —	182
8.3.8	Preservatives —	182
8.3.9	Nutritional additives —	182
8.4	Importance of biopolymer in food industry —	183
8.5	Applications —	184
8.5.1	Biopolymer's conjugation with food dyes —	185
8.5.2	Biopolymer conjugation with anti-caking agents —	186
8.5.3	Enhancement of fruit's shelf life —	187
8.5.4	Replacement of fat with biopolymers —	188
8.5.5	Encapsulation of flavors with the employment of biopolymers —	190
8.6	Benefits of biopolymers —	191
8.7	Challenges and future perspectives —	192
8.8	Conclusions —	193
	References —	193

•

Vivek P. Chavda, Pankti C. Balar, Srushti B. Patel, Diya J. Bhavsar, Margi V. Lakhani and Resa Parmar

9	Antibody biopolymer conjugates in pharmaceuticals —	199
	Objectives —	199
9.1	Introduction —	199
9.2	Antibody biopolymer conjugate —	200
9.3	Mechanism of action —	202

9.4	Requirement —	204
9.5	Formulation —	205
9.5.1	Polymers —	205
9.5.2	Antibody —	208
9.5.3	Conjugation —	208
9.6	Characteristics of ABCs —	209
9.7	Application —	210
9.7.1	Age-related macular degeneration —	211
9.7.2	Diabetic macular edema and diabetic retinopathy —	211
9.7.3	Retinal vein occlusion —	212
9.8	ABCs under preclinical and clinical trails —	213
9.8.1	Preclinical studies —	213
9.8.2	Clinical studies —	214
9.9	Conclusion and future aspects —	217
	References —	217

Trinath Biswal

10	Future perspectives of biopolymeric industry —	223
10.1	Introduction —	223
10.2	Biopolymers and biodegradable polymers —	224
10.3	Benefits and drawbacks of biopolymers —	225
10.3.1	Benefits of biopolymers —	225
10.3.2	Drawbacks of biopolymers —	226
10.4	Future prospective and application of biopolymer in industry —	227
10.4.1	Future prospective and application of some important biopolymers —	228
10.4.2	Future prospectives of different kinds of biopolymers used in textile industries —	229
10.4.3	Future prospective of biopolymer in food industry —	238
10.4.4	Future prospective of biopolymer in biomedical Industry —	240
10.5	Conclusions —	242
	References —	243

Index — 247