
Contents

Preface.....	xi
Author.....	xiii
1. Bionanotechnology and Cellular Biomaterials	1
1.1 Bionanotechnology	1
1.2 Cellular Structures in Bionanotechnology.....	4
References	9
2. Nanostructured Cellular Biomolecules and Their Transformation in Context of Bionanotechnology.....	11
2.1 Nucleic Acids.....	11
2.2 DNA Replication and Genetic Transformation	16
2.3 Central Dogma: Gene-Protein Connections.....	17
2.3.1 Transcription	17
2.3.2 Translation	18
2.3.3 Transformation.....	19
2.4 Hybridization	20
2.5 Proteins and Peptides.....	21
2.6 Amino Acids.....	22
2.6.1 The Peptide Bond.....	24
2.7 Polysaccharides and Lipids	24
References	26
3. Genomics and Bionanotechnology	29
3.1 DNA Nanotechnology and Bionanotechnology	29
3.2 Molecular Genetic Techniques Employing Nanotechnology.....	30
3.3 DNA Amplification.....	31
3.3.1 Application of Polymerase Chain Reaction	33
3.3.1.1 Reverse Transcription-Polymerase Chain Reaction	33
3.3.1.2 <i>In Situ</i> PCR.....	34
3.3.1.3 PCR in Molecular Genetics	34
3.4 Gene Cloning.....	34
3.4.1 Steps of Gene Cloning.....	35
3.4.2 Methods of Gene Cloning.....	36
3.4.3 Application of Gene Cloning.....	37
3.5 Recombination of DNA.....	38
3.6 DNA Sequencing.....	39
3.6.1 Application of Gene Sequencing	40

3.7	Genome Mapping	41
3.8	Human Genome Project.....	41
	References	43
4.	Protein Engineering and Bionanotechnology	45
4.1	Protein Engineering and Bionanotechnology	45
4.2	Protein Engineering Methods.....	46
4.2.1	Rational Design as Nanomaterials.....	46
4.2.2	Directed Evolution of Protein Designing as Nanomaterials	47
4.3	Protein Engineering Applications	48
4.3.1	Applications in Food	49
4.3.2	Medical Applications	50
4.3.3	Environmental Applications	50
4.3.4	Biopolymeric Nanomaterials and Their Functionalities.....	51
4.4	Proteomes and Proteomics	51
4.5	Genomics to Proteomics: Sequential Phenomena in Bionanotechnology	52
4.6	Classification of Proteomics.....	54
4.6.1	Structural Proteomics.....	54
4.6.2	Functional Proteomics	54
4.6.3	Quantitative Proteomics	55
4.6.4	Expression Proteomics	55
4.7	Technology of Proteomics.....	56
4.7.1	Protein Separation and Isolation	56
4.7.2	One-Dimensional Gel Electrophoresis	56
4.7.3	Two-Dimensional Gel Electrophoresis	56
4.7.4	Acquisition of Protein Structural Information.....	57
4.7.4.1	Edman Sequencing	57
4.7.4.2	Mass Spectrometry	57
4.7.4.3	Bioinformatics and Proteomes	58
4.8	Proteomics to Nanoproteomics.....	58
4.9	Applications of Nanoproteomics	59
	References	62
5.	Immune Systems, Molecular Diagnostics, and Bionanotechnology	65
5.1	Introduction	65
5.2	Antibodies.....	65
5.3	Antibody Structure.....	66
5.4	Monoclonal Antibodies.....	67
5.5	Recombinant Antibodies	69
5.6	Antigen–Antibody Interaction.....	69
5.7	Nanoparticles–Antibodies Bioconjugation.....	70

5.8	Therapeutic Applications of Antibody-Based Bioconjugates	72
5.9	Diagnostic Applications of Antibody-Based Bioconjugates	72
5.10	Antibodies-Based Bioconjugates in Biosensor.....	73
5.10.1	Antibodies as Bioreceptors	74
5.10.2	Immunoassay Measurement Formats.....	75
5.10.2.1	Direct Detection Immunoassay Method	76
5.10.2.2	Sandwich Assay	76
5.10.2.3	Indirect Competitive Inhibition Assay	77
5.11	Types of Antibody-Based Biosensors.....	78
5.11.1	Optical Biosensors.....	78
5.11.2	Mass Biosensor	79
5.11.3	Electrochemical Biosensors.....	79
5.12	Antibody-Based Biosensor for Detection of Pathogens.....	80
5.13	Antibody-Based Biosensor for Detection of Toxins	82
5.13.1	Detection of Mycotoxins through Surface Plasmon Resonance	82
	References	83
6.	Bionanofabrication and Bionano Devices in Tissue Engineering and Cell Transplantation	87
6.1	Tissue Engineering	87
6.2	Fabrication of Micro- and Nanodevices for Tissue Engineering	89
6.3	Scaffold Fabrication Methods.....	89
6.4	Microfabrication and Nanolithography.....	91
6.4.1	Replica Molding.....	91
6.4.2	Etching and Direct-Write Method.....	91
6.5	Strategies of Tissue Engineering.....	92
6.5.1	Cell Injection	92
6.5.2	Cell-Induction Therapy.....	92
6.5.3	Cell-Seeded Scaffold	92
6.6	Principles of Tissue Engineering	93
6.6.1	Cell.....	93
6.6.2	Scaffolds.....	94
6.6.3	Biomaterials.....	95
6.6.4	Growth Media.....	96
6.6.5	Bioreactors	97
6.7	Cell Culture.....	97
6.7.1	Primary Cell Culture	98
6.7.2	Adherent Culture and Nonadherent Culture	98
6.7.3	Secondary Cell Culture	98
6.8	Tissue Culture.....	99
6.8.1	Animal Tissue Culture	99
6.8.2	Plant Tissue Culture.....	99
6.9	Three-Dimensional Printing	100

6.10	3D Printing in Tissue Engineering.....	101
6.11	Current and Future Prospect of 3D Printing in Tissue Engineering.....	102
	References	103
7.	Immobilization of Biomolecules	107
7.1	Immobilization.....	107
7.2	Application of Immobilization.....	107
7.3	Supports or Matrix Used for Immobilization.....	109
7.4	Methods of Immobilization.....	110
	7.4.1 Adsorption.....	112
	7.4.2 Entrapment	112
	7.4.3 Microencapsulation.....	113
	7.4.4 Covalent Bonding	113
	7.4.5 Cross-Linking (Copolymerization)	113
7.5	Surface Immobilization.....	114
7.6	Gel Immobilization.....	114
7.7	Immobilization of Bioactive Compounds.....	115
7.8	Immobilization of Live Cells.....	116
	7.8.1 Immobilization of Probiotics.....	118
	7.8.2 Encapsulation Technology in Cell Transplantation.....	119
	7.8.3 Immunocompatibility and Biocompatibility of Materials Used for Encapsulation	121
	7.8.4 Bioencapsulation by Polyelectrolyte Complexation.....	121
	7.8.5 Enhancing the Performance of Microencapsulated Islets and Implantation of Encapsulated Islet Cells in Animals and Clinical Trials.....	124
7.9	Immobilization in Biosensor Fabrication	126
7.10	Immobilization in Chromatography.....	128
	References	129
8.	Nanostructure-Based Delivery Dosage Forms in Pharmaceuticals, Food, and Cosmetics	137
8.1	Introduction.....	137
8.2	Nanoencapsulation.....	137
8.3	Materials Used for Nanoencapsulation	139
8.4	Nanoencapsulation Technique.....	140
8.5	Nanoemulsion	141
8.6	Nanoemulsification Techniques	142
	8.6.1 High-Energy Nanoemulsification	143
	8.6.2 Low-Energy Nanoemulsification.....	144
8.7	Nanoemulsions Finishing Techniques	145
8.8	Nanoemulsions as Delivery Systems	146
8.9	Nanoemulsions in Food Systems.....	147
8.10	Nanoemulsions in Pharmaceutical Industry	149

8.11	Nanoemulsions in Cosmetics Industry	150
8.12	Nanostructure Material as Target Delivery System.....	150
	References	152
9.	Nanoparticles, Biointerfaces, Molecular Recognition, and Biospecificity	157
9.1	Nanoparticles and Biointerface.....	157
9.2	Application of Nanobiointerface in Knowing the Interaction between Surface and Biomolecules.....	161
9.2.1	Nanobiointerface for Targeting and Therapeutic Delivery	161
9.2.2	Targeting Strategies for Drug Delivery at Cell Level and Organ or Tissue Level	161
9.2.3	The Protein (Biomolecule) Corona	163
9.2.4	Electrochemical Nanobiosensors for Food Safety	163
9.3	Molecular Recognition	164
9.3.1	Principle of Molecular Recognition.....	165
9.3.2	Application of Molecular Recognition.....	166
9.3.3	Potential Applications of Biopolymeric Nanoparticles	167
9.3.3.1	Application in Medicine.....	167
9.3.3.2	Application in Food Science	169
9.3.3.3	Application in Biotechnology	171
9.4	Key Parameters for Development of Biopolymeric Nanoparticles.....	172
9.4.1	Biocompatibility of Nanoparticles.....	173
9.4.2	Biodegradability and Safety of Nanoparticles	175
9.5	Conclusion.....	176
	References	176
Index		181