

Contents

Preface

v

1. Introduction to Novel Drug Delivery	1-30
Drug Delivery	1
Physicochemical Properties	11
Biological Factors	13
Potential Applications of Nanocarriers in Targeted Drug Delivery	23
Future Opportunities and Challenges	29
2. Oral Osmotic Pumps	31-51
Introduction	31
Osmosis: An Overview	31
Classification	33
Rose-Nelson Pump	35
Higuchi-Leeper Osmotic Pump	36
Higuchi-Theeuwes Osmotic Pump	37
Elementary Osmotic Pump	37
General Considerations and Materials Used	41
Modified Multichamber Elementary Osmotic Pump	44
Advantages	47
Disadvantages and Limitations	48
3. Bioadhesive and Mucoadhesive Systems	52-81
Introduction	52
Fundamentals of Bioadhesion	53
Mechanism of Bioadhesion	55
Bioadhesion at Exposed Epithelial Surface	59
Naturally Occurring Bioadhesives	59
Factors Affecting Bioadhesion	60
Modulation of Mucoadhesion	63
Adhesion Promoters	63
Mucoadhesive Polymers Used in the Oral Cavity	64
Evaluation of Bioadhesive Drug Delivery Systems	66
Evaluation of Various Bioadhesion Properties	66
X-ray Studies for Monitoring GI Transit	71
Bioavailability Studies of Radiolabeled Nanoparticles	72
Bioavailability Studies of Drug Encapsulated Bioadhesive Microspheres	72
Challenges	78

4. Multiple Emulsions	82-91
Introduction	82
Formulation Aspects of Multiple Emulsions	83
General Methods of Preparation	83
Applications	88
5. Colon-specific Drug Delivery Systems	92-130
Introduction	92
Anatomic and Physiological Considerations	93
Factors Governing the Colon Drug Delivery	95
Targeting Approaches to Colon	101
Formulations for Colon-specific Drug Delivery	116
Conclusion	126
6. Transdermal Drug Delivery Systems	131-156
Introduction	131
Skin: A Biological Barrier to Drug Transport	133
Mechanistic Aspects of Drug Delivery in TDDS	134
Factors affecting percutaneous absorption	136
Characterization of Transdermal Drug Delivery Systems	142
7. Spherical Crystallization	157-171
Introduction	157
Methods of Spherical Crystallization	157
Applications of Spherical Crystallization in Pharmaceuticals	169
8. Microemulsion	172-195
Introduction	172
Methods of Preparation	172
Structure of Microemulsion	174
Formulation of Microemulsion	175
Preparation of Microemulsions	180
Characterization of Lipid Microemulsion	180
9. Implants and Inserts	196-214
Introduction	196
Classification	196
Classification-based on Mechanisms of Drug Release from Implants	197
Implantable Infusion Pump	199
Implantable Mini-osmotic Pump (ALZET)	201
Ophthalmic Inserts	202
Evaluation of Implantable Polymeric Materials	205
Therapeutic Applications of Implants and Inserts	207
Intra-arterial Catheter Infusion Drug Delivery System	211
Present Status and Future Prospects	213

10. Micellar Systems	215–233
Introduction	215
Formation of Micelles	217
Critical Micellar Concentration (CMC)	218
Stability of Polymer Micelle	219
Application of Micelles in Pharmaceutical Science	225
Conclusion	231
11. Liposomes	234–260
Introduction	234
Mechanism(s) of Liposomes Formation	234
Classification of Liposomes	238
Characterization of Liposomes	251
Therapeutic Applications of Liposomes	252
12. Microspheres and Microcapsules	261–288
Introduction	261
Material(s) Used	261
Prerequisites for Ideal Microparticulate Carriers	262
Methods of Preparation	262
Loading of Drug	267
Drug Release Kinetics	268
Characterization of Microparticles	270
Various Types of Polymeric Microspheres	271
Fate of Microspheres in Body	278
Applications of Microspheres	279
Chemoembolization	284
13. Nanoparticles	289–317
Introduction	289
Preparation Techniques of Nanoparticles	290
Characterization of Nanoparticles	302
Therapeutic Applications of Nanoparticles	304
Magnetic Nanoparticles	312
14. Resealed Erythrocytes	318–341
Introduction	318
Composition of Erythrocytes	318
Erythrocytes Morphology	319
<i>In Vitro</i> Characterization	323
<i>In Vivo</i> Survival and Immunological Consequences	325
Pharmacokinetics of Drugs or Peptides Administered in Loaded Erythrocytes	326
Applications of Carrier Red Cells	327
Other Applications	338

15. Transfersomes and Ethosomes	342–358
Introduction	342
Skin	343
Transfersomes	344
Ethosomes	351
16. Organogels	359–377
Introduction	359
Organogelators	360
Properties of Organogelators	365
Low Molecular Weight Organogelators	367
Organogels as Drug Delivery Vehicles	370
17. Dendrimers	378–392
Introduction	378
Origin of Dendrimers	379
Dendrimers and Polymers: A Comparison	380
Properties of Dendrimers	381
Featured Advantages of Dendrimers as Drug Carrier	381
Classification of Dendrimers	381
Synthesis and Designing of Dendrimers	382
Analytical Methods for Structure Validation of Dendrimers	384
Dendrimer Toxicity	385
18. Niosomes	393–415
Introduction	393
Formulation Aspects	394
Methods of Preparation	399
Characterization of Niosomes	401
Stability of Niosomes	404
Types of Niosomes	405
Applications of Niosomes	409
19. Solid Lipid Nanoparticles	416–439
Introduction	416
Advantages of SLNs as Alternative Particulate Carrier	416
SLNs versus Other Colloidal Drug Carriers	417
Ingredients and Formulation Processes	418
Microemulsion-based SLNs Preparations	420
Influence of Ingredient Composition on Product Quality	424
Characterization of SLNs	425
Toxicity Aspects and <i>In Vivo</i> Fate of SLNs	434
Applications of SLNs in Drug Delivery	434

20. Drug Conjugates **440–469**

- Introduction 440
- Bioconjugate Techniques 440
- Glutaraldehyde-based Hapten-carrier Conjugation 447
- Carbodiimide-based Conjugation to Phosphatidylethanolamine Lipid Derivatives 447
- Glutaraldehyde-based Conjugation to Phosphatidylethanolamine Lipid Derivative 447
- Avidin-biotin System 448
- Preparation of Colloidal Gold-labeled Proteins 449
- Radiolabeled Antibodies 450
- Antibody-toxin Conjugates 451
- Protein Conjugates of Fungal Toxins 452
- Poly-L-lysine Conjugates 453
- Dextran and Inulin Conjugates as Drug Carriers 456
- Lectin as Carrier 456
- Glycoproteins as Drug Carriers 457
- Galactose Terminated Fetuin as Carriers for Pepstatin 457
- Bioconjugates with Protein Drugs 458
- Polymer-drug Conjugates 459
- Advantages in the Preparation of Bioconjugates with Low Molecular Weight Drugs 461
- Limitations in the Conjugation of Polymers to Low Molecular Weight Drugs 462
- Polyglutamic Acid (PGA)-E-[c(RGDfk)₂]-paclitaxel Conjugate 463
- N-(2-hydroxypropyl) Methacrylamide (HPMA)-based Polymeric Drug Conjugates 465
- Polyethylene Glycol (PEG)-based Polymeric Drug Conjugates 467

21. Cyclodextrin Complexes **470–488**

- Introduction 470
- Cyclodextrin-based Products 471
- Advantages 472
- Limitations 473
- Mechanism of Drug Cyclodextrin Complexation 473
- Inclusion and Noninclusion Complexes 475
- Methods to Enhance the Complexation Efficiency 476
- Toxicological Aspects 476
- Drug Availability from CD-containing Products 477
- Regulatory Status 477
- Patents 478
- Pharmaceutical Applications of Drug-CD Complexes 479
- CD Used in the Design of Delivery Systems 483

22. Multifunctional Nanomedicines	489-509
Introduction	489
Designing of Multifunctional Nanomedicines	490
Applications	493
23. Floating Drug Delivery System(s)	510-527
Introduction	510
Low Density System or Floating Drug Delivery System	511
Classification of FDDS: Classification of Single Unit FDDS	512
Classification of Multiple Unit FDDS	513
Raft Forming Systems	515
Ingredients Used in Preparation of FDDS	515
List of Drugs Explored for Various Floating Dosage Forms	515
Approaches to Design FDDS	516
Formulation Development and Mechanism of FDDS	519
<i>In Vitro</i> and <i>In Vivo</i> Evaluation	520
Advantages of FDDS	521
Disadvantages of FDDS	522
Marketed Products of FDDS	522
Applications of FDDS	523
Pharmaceutical Aspects	525
Future Perspectives in FDDS	525