

CONTENTS

Contributors	xi
1. The Significance of Biomimetic Membrane Nanobiotechnology to Biomedical Applications	1
Donald K. Martin	
1.1. Introduction.....	1
1.2. Interaction of Lipid Membranes with Transport Proteins.....	3
1.3. Reaction of Eukaryotic Cells to the Physical Environment.....	4
1.3.1. Example of the Influence of Membrane Ion Channels on the Biology of Endothelial Cells	5
1.3.2. Mechanical Transduction of Stress in Lipid Bilayers.....	8
1.4. What is the Relevance of Lipid Bilayer Membranes to Nanotechnology?	10
1.5. Can Biosensor Technology Benefit from Biomimetic Membrane Nanobiotechnology?	13
1.6. Does Biomimetic Membrane Nanobiotechnology Assist in Drug Delivery?	15
1.7. Can Implants Benefit from Biomimetic Membrane Nanobiotechnology?.....	16
1.8. Concluding Remarks.....	17
2. Langmuir-Blodgett Technique for Synthesis of Biomimetic Lipid Membranes	23
Agnès P. Girard-Egrot and Loïc J. Blum	
2.1. Introduction.....	23
2.2. Langmuir Monolayer Formation	25
2.2.1. Surface Tension.....	26
2.2.2. Surfactants	27
2.2.3. Surface Pressure	30

2.2.4. Surface Pressure (π) – Area (A) Isotherms	33
2.2.5. Monolayer Stability.....	37
2.3. Langmuir-Blodgett Technique.....	39
2.3.1. Vertical Film Deposition Principles	39
2.3.1.1. Transfer Process Energy.....	41
2.3.1.2. Contact Angle Values	42
2.3.1.3. Deposition Ratio.....	43
2.3.1.4. Advantages and Caution	43
2.3.2. Elaboration of Organised Lipidic LB Films	44
2.3.3. Phospholipid LB Films	47
2.3.4. Free Supported Phospholipid LB Films	52
2.3.5. Asymmetric Phospholipid LB Bilayers.....	54
2.4. Functionalisation of Lipidic LB Films: Specific Features.....	57
2.4.1. Protein Association with the Floating Monolayer before LB Deposition	57
2.4.2. Protein Association onto Preformed-Lipidic LB Films	59
2.4.3. Oriented Protein Association in Lipidic LB Films	60
2.5. Trends and Prospects	62
3. Liposome Techniques for Synthesis of Biomimetic Lipid Membranes	75
Stella M. Valenzuela	
3.1. Introduction.....	75
3.2. Applications and Uses of Liposomes.....	75
3.3. Liposome Structure is Influenced by its Phospholipid Composition	76
3.4. Common Terminology Used in the Description of Liposome Structure	77
3.5. Liposome Preparation.....	77
3.5.1. Preparation of Multilamellar Vesicles.....	78
3.5.2. Preparation of Unilamellar Vesicles.....	79
3.5.2.1. Ultrasonication.....	79
3.5.2.2. Extrusion through Polycarbonate Filters	79
3.5.2.3. Freeze – Thawing	79
3.5.2.4. Ethanol Injection	81
3.5.2.5. Detergent Method.....	81
3.5.2.6. Preparation of Sterile Large Unilamellar Vesicles	81
3.5.3. Preparation of Giant Unilamellar Liposomes.....	82
3.5.3.1. Electroformation.....	82
3.5.3.2. Rapid Preparation of Giant Liposomes.....	82
3.5.3.3. Giant Unilamellar Liposomes Prepared in Physiological Buffer.....	83
3.5.4. Modified Liposomes	83
3.5.5. Purification of Liposomes.....	85

4. Characterization and Analysis of Biomimetic Membranes	89
Adam I. Mechler	
4.1. Important Properties of Biomimetic Membranes.....	89
4.2. Methods of Characterization and Analysis	91
4.2.1. A Few Thoughts.....	91
4.2.2. Atomic Force Microscopy	92
4.2.3. Quartz Crystal Microbalance.....	96
4.2.4. Surface Force Apparatus.....	96
4.2.5. Ellipsometry	97
4.2.6. Surface Plasmon Resonance	98
4.3. Coverage and Mass.....	99
4.4. Morphology and Mechanical Properties	104
4.4.1. Imaging and a Few Common Artefacts	104
4.4.2. Surface Forces and Continuum Mechanics; AFM Simulation.....	107
4.4.3. Mechanical Properties.....	118
4.5. A Brief Outlook.....	122
5. Biomimetic Membranes in Biosensor Applications	127
Till Böcking and J. Justin Gooding	
5.1. Introduction.....	127
5.2. Biosensors	129
5.2.1. Classes of Biosensors.....	129
5.2.2. Why Biomimetic Membranes for Biosensing Applications? ..	130
5.3. Biomimetic Membranes for Biosensor Applications.....	133
5.3.1. Hybrid Bilayer Lipid Membranes (Supported Lipid Monolayers).....	134
5.3.2. Solid Supported “Floating” Bilayer Lipid Membranes.....	134
5.3.3. Tethered Bilayer Lipid Membranes.....	137
5.3.3.1. Surface Attachment via Low Molecular Weight Tethers.....	137
5.3.3.2. Phytanyl Lipid Derivatives for Highly Insulating Membranes	138
5.3.3.3. Surface Attachment via Functionalised Polymers.....	140
5.3.4. Laterally Structured Bilayer Lipid Membranes.....	140
5.4. Catalytic and Affinity Biosensors Fabricated using Supported Bilayer Lipid Membranes	141
5.4.1. Catalytic Biosensors based on Supported BLMs.....	141
5.4.2. Affinity Biosensors	143
5.4.2.1. Immunosensors based on Supported BLMs	143
5.4.2.2. DNA Modified BLMs	143
5.4.2.3. Detection of Toxins using Hybrid BLMs, Supported BLMs and Vesicles.....	143

5.4.3. General Remarks on Supported BLMs for Biosensing Applications.....	147
5.5. Membrane Biosensors Based on Ion Channel Gating	148
5.5.1. Signal Transduction via Ion Channels.....	148
5.5.1.1. Criteria for the Biomimetic Membrane	148
5.5.1.2. Measurement of Membrane Conductance	149
5.5.1.3. Gating of Ion Channels Incorporated into Tethered BLMs.....	149
5.5.1.4. Gating of Ion Channels Incorporated into Membranes on a Sensor Chip	150
5.5.2. Taking Biosensors a Step Further: The AMBRI Ion Channel Switch Biosensor	150
5.6. Concluding Remarks.....	154
About the Contributors	167
Index	171