

# Contents

Dedication	v
Preface	vii
Acknowledgements	ix
List of Tables	xv
List of Figures	xvii
<b>Chapter 1 Protein Bioseparation: An Overview</b>	<b>1</b>
1.1 Introduction	1
1.2 Proteins	1
1.3 Protein products	2
1.4 The requirement for protein bioseparation	3
1.5 Economic aspects of protein bioseparation	5
1.6 Protein bioseparation methods	5
<b>Chapter 2 Ultrafiltration: An Overview</b>	<b>13</b>
2.1 Introduction	13
2.2 Applications of ultrafiltration	13
2.3 Advantages of ultrafiltration	15
<b>Chapter 3 Membranes</b>	<b>19</b>
3.1 Introduction	19
3.2 Membrane material and chemistry	19

3.3	Membrane structure and morphology	21
3.4	Membrane preparation	23
3.5	Driving force in membrane separation processes	24
3.6	Membrane characterisation	26
<b>Chapter 4 Membrane Module and Operation</b>		<b>33</b>
4.1	Membrane elements and modules	33
4.2	Mode of operation	44
<b>Chapter 5 Membrane Fouling</b>		<b>47</b>
5.1	Introduction	47
5.2	Fouling mechanisms	48
5.3	Chemistry of adsorption	51
5.4	Initial and long-term fouling	52
5.5	Effect of concentration polarisation on fouling	54
5.6	Effect of permeate flux on fouling, and the critical flux concept	54
5.7	Effect of physicochemical parameters on fouling	54
<b>Chapter 6 Permeate Flux in Ultrafiltration</b>		<b>57</b>
6.1	Permeate flux	57
6.2	Enhancement of permeate flux	63
6.3	Fouling control	68
<b>Chapter 7 Protein Transmission Through Ultrafiltration Membranes</b>		<b>75</b>
7.1	Protein size	75
7.2	Protein transmission	75
<b>Chapter 8 Selectivity of Protein Fractionation in Ultrafiltration</b>		<b>87</b>
8.1	Selectivity	87
8.2	Enhancement of selectivity	89

<b>Chapter 9 Protein Concentration</b>	<b>91</b>
9.1 Introduction	91
9.2 Solute retention	92
9.3 Permeate flux and fouling in concentration processes	94
9.4 Modules	95
9.5 Mode of operation	96
9.6 Applications	101
<b>Chapter 10 Diafiltration of Protein Solutions</b>	<b>105</b>
10.1 Introduction	105
10.2 Permeate flux and fouling in diafiltration	105
10.3 Modules	107
10.4 Mode of operation	108
10.5 Applications	108
<b>Chapter 11 Protein Clarification</b>	<b>111</b>
11.1 Introduction	111
11.2 Protein transmission	111
11.3 Permeate flux and fouling in protein clarification	112
11.4 Particle transmission through UF membrane	112
11.5 Modules	113
11.6 Mode of operation	114
11.7 Applications	118
<b>Chapter 12 Protein Fractionation</b>	<b>121</b>
12.1 Introduction	121
12.2 Challenges facing ultrafiltration based protein fractionation	121
12.3 Selectivity enhancement	123
12.4 Thumb rules for protein fractionation	133
12.5 Application areas	135

<b>Chapter 13</b>	<b>New Developments</b>	<b>145</b>
13.1	New membranes	145
13.2	New membrane modules	146
13.3	Rapid process optimisation techniques	147
13.4	New modes of operation	148
<b>Appendix A</b>	<b>Glossary of Membrane Terminology</b>	<b>155</b>
<b>Appendix B</b>	<b>List of Membrane Manufacturers</b>	<b>163</b>
<b>Appendix C</b>	<b>Websites of Membrane Related Academic and Research Institutions</b>	<b>165</b>