

	1
1. Introduction	5
1.1 Background and Motivations	5
1.2 Overview	7
2 Formal Languages Elements	11
2.1 Alphabets and Languages	11
2.2 Chomsky Grammars	13
2.2.1 Definitions	13
2.2.2 Normal Forms	14
2.3 Automata	15
2.3.1 Finite Automata	15
2.3.2 Push Down Automata	16
2.3.3 Turing Machines	18
2.4 Grammars with Controlled Derivations: Matrix Grammars and Ordered Grammars	20
2.5 Computational Complexity	22
3. Membrane Systems	27
3.1 Membrane Structure and Membrane Systems: Definitions	28
3.2 Examples	35
3.3 The Power of Membrane Systems	40
3.3.1 Membrane Systems with Internal Output	41
3.3.2 membrane Systems with External Output	42
3.4 Rewriting Membrane Systems	43
3.4.1 Definitions	43
3.4.2 The Power of Rewriting Membrane Systems	45
3.5 Splicing Membrane Systems	48
3.5.1 Definitions	49
3.5.2 The Power of Splicing Membrane Systems	50
4. Membrane Systems with Regulated Rewriting	57
4.1 Priority Relations Among Evolution Rules	58
4.2 Leftmost Derivations in Membrane Systems	62
4.3 Permitting and Forbidding Rewriting Conditions in Membrane Systems	66
4.4 Considering Features Associated with the Membranes	71
5. Membranes of Variable Thickness	75
5.1 Membranes of Variable Thickness: Definition	75
5.2 Membranes of Variable Thickness and Rewriting P Systems	76
6. Electrical Charges	87
6.1 Rewriting P Systems with Priority and with Polarized Membranes ..	88
6.2 Rewriting P Systems without Priority and with Polarized Membranes	92

7. Membrane Division	99
7.1 P Systems with Active membranes	100
7.2 Solving NP Complete Problems Using P Systems with Elementary Active Membranes	273
7.3 P Systems without Active Membranes	108
8. Conclusions and Future Work	113
8.1 Conclusions	113
8.2 Future Work	115
A Appendix - The Cell Structure and Its Organization	119