

Contents

1	Biological Preliminaries	1
1.1	The Uterus	1
1.2	Functional Unit	2
1.3	Electrophysiological Properties	4
1.4	Neuroendocrine Modulators	6
1.5	Coupling Phenomenon	9
1.6	Crosstalk Phenomena	11
2	Models of the Gravid Uterus	15
2.1	Biological Changes in Pregnant Uterus	15
2.2	Mechanical Models of the Gravid Uterus	17
2.3	Models of Myoelectrical Activity	23
3	A Dynamic Model of the Fasciculus	29
3.1	Formulation of the Model	29
3.2	Effect of Changes in the Ionic Environment on Myoelectrical Activity	34
3.2.1	Physiological Condition	34
3.2.2	Changes in Ca_0^{2+}	34
3.2.3	Changes in K_0^+	35
3.2.4	Changes in Cl_0^-	38
3.3	Effects of Ion Channel Agonists/Antagonists	39
3.3.1	T-Type Ca^{2+} Channels	39
3.3.2	L-Type Ca^{2+} Channels	41
3.3.3	BK_{Ca} Channels	44
3.3.4	K^+ Channels	46
3.3.5	Cl^- Channels	47
4	General Theory of Thin Shells	51
4.1	Basic Assumptions	51
4.2	Geometry of the Surface	52

4.3	Tensor of Affine Deformation	56
4.4	Equations of Continuity of Deformations	59
4.5	Equations of Equilibrium	61
5	Essentials of the Theory of Soft Shells	65
5.1	Deformation of the Shell	65
5.2	Principal Deformations	71
5.3	Membrane Forces	74
5.4	Principal Membrane Forces	76
5.5	Equations of Motion in General Curvilinear Coordinates	78
5.6	Nets	81
5.7	Corollaries of the Fundamental Assumptions	82
6	Continual Model of the Myometrium	85
6.1	Basic Assumptions	85
6.2	Model Formulation	86
6.3	Biofactor Z_{kl}	91
6.4	Special Cases	94
7	Models of Synaptic Transmission and Regulation	97
7.1	System Compartmentalization	97
7.2	cAMP-Dependent Pathway	105
7.3	PLC Pathway	107
7.4	Co-transmission in Myometrium	109
7.4.1	Co-transmission by Acetylcholine and Oxytocin	111
7.4.2	Co-transmission by Acetylcholine and Adrenaline	112
7.4.3	Co-transmission by Oxytocin and Adrenaline	114
7.4.4	Co-transmission by Oxytocin and Prostaglandins	114
8	Pharmacology of Myometrial Contractility	117
8.1	Classes of Drugs	117
8.2	Current Therapies of Myometrial Dysfunction	119
8.3	Model of Competitive Antagonist Action	120
8.4	Model of Allosteric Interaction	122
8.5	Allosteric Modulation of Competitive Agonist/Antagonist Action	124
8.6	Model of PDE-4 Inhibitor	126
9	Gravid Uterus as a Soft Biological Shell	129
9.1	Fundamental Assumptions	129
9.2	Model of the Gravid Uterus	131
9.3	Numerical Simulations	137
9.3.1	Uterus Close to Term	138
9.3.2	First Stage of Labor	141
9.3.3	Second Stage of Labor	144

9.3.4 Third Stage of Labor	147
9.3.5 Constriction Ring	148
9.3.6 Uterine Dystocia	149
9.3.7 Hyper- and Hypotonic Uterine Inertia	151
10 Biomechanics of the Gravid Uterus in Perspective	155
10.1 Ontology of Models	155
10.2 Applications, Pitfalls, and Problems	158
References	163
Index	175