Contents

Preface — V

List of authors --- XV

Part I: Molecular level

Monika	a Piwowar and Wiktor Jurkowski
1	Selected aspects of biological network analysis — 3
1.1	Introduction —— 3
1.2	Selected biological databases — 5
1.2.1	Case study: Gene Expression Omnibus —— 6
1.2.2	RegulonDB —— 9
1.3	Types of biological networks —— 10
1.3.1	Relations between molecules and types of networks —— 10
1.3.2	Biochemical pathways —— 12
1.4	Network development models —— 14
1.4.1	Selected tools for assembling networks on the basis
	of gene expression data —— 14
1.4.2	Selected tools for reconstruction of networks
	via literature mining —— 15
1.5	Network analysis —— 16
1.5.1	Selected tools —— 17
1.5.2	Cytoscape analysis examples —— 23
1.6	Summary —— 25

Part II: Cellular level

1.6

Jakub Wach, Marian Bubak, Piotr Nowakowski, Irena Roterman, Leszek Konieczny, and Katarzyna Chłopaś

Negative feedback inhibition – Fundamental biological regular in cells and organisms — 31	
2.1	Negative feedback-based systems simulations — 41
2.1.1	Introduction —— 41
2.1.2	Glossary of Terms —— 41
2.1.3	Software model 42
2.1.4	Application manual —— 45
2.1.5	OS model example —— 50

Simulation algorithm ---- 52



2.1.6

	erman-Konieczna nformation – A tool to interpret the biological phenomena —— 57
Part III:	Organ level
Anna Sochocka and Tomasz Kawa The virtual heart —— 65	
Marc Ebn	er and Stuart Hameroff
5 A	Modeling figure/ground separation with spiking neurons —— 77
5.1	Introduction — 77
5.2	Figure/ground separation —— 79
5.3	Spiking neural networks —— 81
5.4	Lateral connections via gap junctions —— 82
5.5	Simulation of a sheet of laterally connected neurons —— 84
5.6	Basis of our model —— 91
5.7	Conclusion — 92
Part IV:	Whole body level
Ryszard 1	adeusiewicz
-	Simulation-based analysis of musculoskeletal system properties 9
6.1	Introduction —— 99
6.2	Components of a motion simulation model —— 101
6.2.1	Simulating the skeleton —— 102
6.2.2	Bone model simulations —— 105
6.2.3	Muscle models —— 110
6.2.4	Velocity-dependent simulations of the muscle model —— 116
6.3	Summary —— 118
6.4	Simulation software available for download —— 118
Part V:	Diagnostics procedure
•	A. Kononowicz and Inga Hege
7 1	The world of virtual patients 121
7.1	Introduction —— 121
7.2	What are virtual patients? —— 121
7.3	Types of virtual patient —— 122
7 /	The metivation behind virtual nationts —— 125

7.5	Theoretical underpinnings of virtual patients —— 125
7.5.1	Experiential learning theory —— 126
7.5.2	Theory of clinical reasoning —— 127
7.6	The technology behind virtual patients —— 128
7.6.1	Virtual patient systems —— 129
7.6.2	Components of virtual patients —— 130
7.6.3	Standards — 132
7.7	How to use virtual patients? —— 132
7.7.1	Preparation for or follow-up of face-to-face teaching —— 133
7.7.2	Integration into a face-to-face session —— 133
7.7.3	Assessment —— 133
7.7.4	Learning-by-teaching approach —— 134
7.8	The future of virtual patients —— 134
Dick Da	avies, Peregrina Arciaga, Parvati Dev, and Wm LeRoy Heinrichs
8	Interactive virtual patients in immersive clinical environments:
	The potential for learning 139
8.1	Introduction —— 139
8.2	What are virtual worlds? —— 140
8.3	Immersive Clinical Environments (Virtual Clinical Worlds) —— 141
8.4	Virtual patients —— 141
8.5	Interactive virtual patients in immersive clinical environments —— 143
8.6	Case study: Using immersive clinical environments for
	Inter-Professional Education at Charles R. Drew University
	of Medicine 144
8.6.1	Introduction to case study —— 144
8.6.2	The case study —— 145
8.6.3	Assessment —— 158
8.6.4	Summary and lessons learned —— 160
8.7	The potential for learning —— 161
8.7.1	Why choose immersive clinical environments? —— 161
8.7.2	Decide 164
8.7.3	Design —— 166
8.7.4	Develop —— 167
8.7.5	Deploy —— 172
8.8	Conclusion: "Learning by Doing Together" —— 173
Joanna	Jaworek-Korjakowska and Ryszard Tadeusiewicz
9	Melanoma thickness prediction —— 179
9.1	Introduction —— 179
9.2	Motivation —— 180
9.3	Clinical definition and importance —— 181

9.4	Algorithm for the determination of melanoma thickness — 184		
9.5	Melanoma thickness simulations —— 187		
9.6	Conclusions —— 192		
Part V	Part VI: Therapy		
Ryszaro	l Tadeusiewicz		
10	Simulating cancer chemotherapy —— 197		
10.1	Simulating untreated cancer —— 197		
10.2	Enhanced model of untreated cancer —— 200		
10.3	Simulating chemotherapy —— 202		
10.4	Simulation software available for the reader —— 206		
Piotr D	udek and Jacek Cieślik		
11	Introduction to Reverse Engineering and Rapid Prototyping		
	in medical applications —— 207		
11.1	Introduction —— 207		
11.2	Reverse Engineering —— 207		
11.2.1	Phase one – Inputs of medical RE —— 209		
11.2.2	Phase two – Data acquisition —— 210		
11.2.3	Phase three – Data processing —— 212		
11.2.4	Phase four – Biomedical applications —— 214		
11.3	Software for medical RE —— 215		
11.3.1	Mimics Innovation Suite —— 215		
11.3.2	Simpleware ScanIP —— 216		
11.3.3	3D-DOCTOR —— 217		
11.3.4	Amira —— 217		
11.3.5	Other software for 3D model reconstruction —— 218		
11.3.6	RE and dimensional inspection —— 219		
11.3.7	Freeform modeling —— 219		
11.3.8	FEA simulation and CAD/CAM systems —— 219		
11.4	Methods of Rapid Prototyping for medical applications –		
	Additive Manufacturing —— 220		
11.4.1	Liquid-based RP technology —— 222		
11.4.2	Stereolithography (SLA) —— 222		
11.4.3	Polymer printing and jetting — 223		
11.4.4	Digital Light Processing (DLP) —— 224		
11.4.5	Solid sheet materials —— 225		
11.4.6	Fused Deposition Modeling (FDM) —— 226		
11.4.7	Selective Laser Sintering (SLS) — 227		
11.4.8	Selective Laser Melting (SLM) —— 227		

11.4.9	Electron Beam Melting (EBM) —— 228
11.4.10	Tissue engineering —— 229
11.5	Case studies —— 230
11.5.1	One-stage pelvic tumor reconstruction —— 230
11.5.2	Orbital reconstruction following blowout fracture —— 232
11.6	Summary —— 233
Zdzisław V	Viśniowski, Jakub Dąbroś, and Jacek Dygut
12 Co	omputer simulations in surgical education —— 235
12.1	Introduction —— 235
12.2	Overview of applications —— 235
12.2.1	Gray's Anatomy Student Edition, Surgical Anatomy – Student Edition, digital editions of anatomy textbooks for the iOS (free) and Android (paid) —— 236
12.2.2	Essential Skeleton 4, Dental Patient Education Lite, 3D4Medical Images and Animations, free educational software by 3D4Medical.com, available for iOS, Android (Essential Skeleton 3 – earlier version; paid editions of Essential Anatomy 3 and iMuscle 2) —— 236
12.2.3	SpineDecide – An example of point of care patient education for healthcare professionals, available for iOS —— 239
12.2.4	iSurf BrainView – Virtual guide to the human brain, available for iOS —— 240
12.2.5	Monster Anatomy Lite – Knee – Orthopedic guide, available for iOS (Monster Minds Media) —— 241
12.2.6	AO Surgery Reference – Orthopedic guidebook for diagnosis and trauma treatment, available for iOS and Android —— 243
12.2.7	iOrtho+ – Educational aid for rehabilitationists, available for iOS and Android —— 245
12.2.8	DrawMD – Based on General Surgery and Thoracic Surgery by Visible Health Inc., available for iOS —— 247
12.2.9	MEDtube, available for iOS and Android — 250
12.3	Specialized applications —— 254
12.3.1	Application description —— 255
12.4	Simulators — 262
12.4.1	Selected examples of surgical simulators —— 263
12.5	Summary — 265

Part VII: Support of therapy

Łukasz	Czekierda, Andrzej Gackowski, Marek Konieczny, Filip Malawski,
Kornel S	Skałkowski, Tomasz Szydło, and Krzysztof Zieliński
13	From telemedicine to modeling and proactive medicine —— 271
13.1	Introduction —— 271
13.2	ICT-driven transformation in healthcare —— 272
13.2.1	Overview of telemedicine —— 272
13.2.2	Traditional model of healthcare supported by telemedicine —— 273
13.2.3	Modeling as knowledge representation in medicine —— 274
13.2.4	Towards a personalized and proactive approach in medicine —— 275
13.2.5	Model of proactive healthcare —— 277
13.3	Computational methods for models development —— 278
13.3.1	Computational methods for imaging data —— 281
13.3.2	Computational methods for parametric data —— 282
13.4	TeleCARE – telemonitoring framework —— 282
13.4.1	Overview —— 282
13.4.2	Contribution to the model-based proactive medicine concept —— 284
13.4.3	Case study —— 286
13.5	TeleDICOM – system for remote interactive consultations —— 287
13.5.1	Overview —— 287
13.5.2	Contribution to the model-based proactive medicine concept —— 288
13.6	Conclusions —— 290
14	Serious games in medicine —— 295
Paweł V	Vęgrzyn
14.1	Serious games for health – Video games and health issues —— 295
14.1.1	Introduction —— 295
14.1.2	Previous surveys —— 296
14.1.3	Evidence review —— 299
14.1.4	Conclusions —— 310
Ewa Gra	abska
14.2	Serious game graphic design based on understanding of a new model of visual perception – computer graphics —— 318
14.2.1	Introduction —— 318
14.2.2	A new model of perception for visual communication —— 319
14.2.3	Visibility enhancement with the use of animation —— 322
14.2.4	Conclusion —— 323

Irena Roterman-Konieczna

14.3	Serious gaming in medicine —— 324
14.3.1	Therapeutic support for children 324

14.3.2 Therapeutic support for the elderly — 324

14.3.2 Therapeutic support for the elderly — 327

Index ---- 329