

CONTENTS

Contributors	ix
Preface	xiii
A. Cell Nucleus: Organization & MechanoBiology	1
1. Fluorescence Fluctuation Microscopy to Reveal 3D Architecture and Function in the Cell Nucleus	
<i>Thorsten Lenser, Klaus Weisshart, Tobias Ulbricht, Karolin Klement, and Peter Hemmerich</i>	
I. Introduction	4
II. Rationale	14
III. Materials and Methods	14
IV. Results and Discussion	25
V. Conclusions	28
References	30
2. Studying Histone Modifications and Their Genomic Functions by Employing Chromatin Immunoprecipitation and Immunoblotting	
<i>Ranveer S. Jayani, Praveena L. Ramanujam, and Sanjeev Galande</i>	
I. Introduction	36
II. Rationale	42
III. Chromatin Immunoprecipitation	42
IV. Immunoblotting and Coomassie Staining	46
V. Discussion	49
VI. Summary	52
References	52
3. Dynamic Organization of Chromatin Assembly and Transcription Factories in Living Cells	
<i>Bidisha Sinha, Dipanjan Bhattacharya, Deepak Kumar Sinha, Shefali Talwar, Shovanayee Maharana, Soumya Gupta, and G. V. Shivashankar</i>	
I. Introduction	58
II. Chromatin Dynamics	59
III. Higher-Order Chromosome Compaction	65
IV. Nuclear Plasticity	69
V. Spatio-temporal Organization of Transcription Factories and Gene Loci	71
VI. Conclusions	75
References	76

4. Manipulation and Isolation of Single Cells and Nuclei	
<i>Suwei Jin Tan, Qingsen Li, and Chuwei Teck Lin</i>	
I. Introduction	80
II. Techniques for Single-Cell Manipulation	81
III. Nuclear Isolation and Manipulation	89
IV. Discussion and Future Implications	92
References	92
5. Beyond Lamins: Other Structural Components of the Nucleoskeleton	
<i>Zhixia Zhong, Katherine L. Wilson, and Kris Noel Dahl</i>	
I. Introduction	98
II. Methods	106
III. Discussion and Prospects	114
References	114
6. Altered Mechanical Properties of the Nucleus in Disease	
<i>Maria Lucia Lombardi and Jan Lammerding</i>	
I. Introduction	122
II. Rationale	124
III. Materials	125
IV. Methods	127
V. Results and Discussion	135
VI. Summary	138
References	138
7. Theoretical Concepts and Models of Cellular Mechanosensing	
<i>Rumi De, Assaf Zemel, and Samuel A. Safran</i>	
I. Introduction	144
II. Macromolecular Components Involved in Cellular Mechanosensing	145
III. Cell Adhesion	148
IV. Active and Passive Mechanics of the Cytoskeleton	151
V. Slow Mechanical Processes in the Cytoskeleton	156
VI. Cellular Response to External Mechanical Stress	159
VII. Discussion	168
References	169
B. Impact of Nuclear Mechanics on Function	
8. Mechanical Induction of Gene Expression in Connective Tissue Cells	
<i>Matthew W. C. Chan, Boris Hinz, and Christopher A. McCulloch</i>	
I. Introduction	180
II. Extracellular Matrix Environment	181

III. Mechanical Signaling	182
IV. Overview of Methods for Mechanical Cell Stimulation	184
V. Cardiac Fibrosis and Mechanical Induction of Gene Expression	188
VI. Conclusions	195
References	197
 9. Physical Plasticity of the Nucleus and its Manipulation	
<i>Irena Ivanovska, Joe Swift, Takamasa Harada, J. David Pajerowski,</i> <i>and Dennis E. Discher</i>	
I. Introduction	208
II. Micropipette Aspiration	208
III. Molecular Mechanisms from Reengineered Nuclei	214
IV. Isolation of Individual Nuclei	217
V. Outlook	219
References	219
 10. Prestressed Nuclear Organization in Living Cells	
<i>Aprotin Mazumder, T. Roopa, Abhishek Kumar, K. Venkatesan Iyer,</i> <i>Nisha M. Randas, and G. V. Shivashankar</i>	
I. Introduction	222
II. Mechanics of Isolated Nucleus	222
III. Nuclear Prestress in Cellular Context	228
IV. Conclusions	235
References	236
 11. Nanotopography/Mechanical Induction of Stem-Cell Differentiation	
<i>Benjamin Kim Kiat Teo, Soneela Arkan, Lesley Y. Chan, and Evelyn K. F. Yim</i>	
I. Introduction	242
II. Types of Topological Patterns	242
III. Stem Cell Reception to Substrate Topology	248
IV. Cell Shape: A Regulator of Biological Processes	278
V. Conclusions	287
References	288
 12. Mechanical Induction in Embryonic Development and Tumor Growth: Integrative Cues Through Molecular to Multicellular Interplay and Evolutionary Perspectives	
<i>Maria-Elena Fernandez-Sanchez, Fanny Sernan, Padra Ahmadi, and Emmanuel Farge</i>	
I. Introduction	296
II. Genetic Control of Morphogenetic Movements: Underlying Molecular Mechanisms and Evaluation of Forces	298
III. Mechanical Control of Gene Expression: Testing Mechanical Induction by Application of Endogenous Forces from the Inside of the Embryo	302

IV. Mechanotransduction in the Control of Posttranslational Morphogenetic Events: Mechanical Activation of the Myosin-II Apico-Basal Polarity Triggering Mesoderm Invagination	310
V. Incidences of Mechanical Induction in Tumor Development	316
VI. Mechano-Genetics Network in Perspective of Evolution: Reactivation of a Primitive Feeding Response of Ancient Embryos Recapitulated in Embryonic Morphogenetic Invagination? Mechanical Induction in First Multicellular Organism Emergence?	318
References	319
 13. Informatics-Based Analysis of Mechanosignaling in the Laminopathies	
<i>Frank P. L. Lai, Radfidah A. Mutalif, Siew Cheng Phua, and Colin L. Stewart</i>	
I. Introduction	324
II. Methods	326
III. Reagents and Equipment for Subjecting Cells to Uniaxial Strain	331
IV. Discussion	333
V. Summary	334
References	334
 14. Autosomal Dominant Leukodystrophy Caused by Lamin B1 Duplications: A Clinical and Molecular Case Study of Altered Nuclear Function and Disease	
<i>Quasar Saleem Padiath and Ying-Hui Fu</i>	
I. Introduction	338
II. Leukodystrophies	340
III. Adult-Onset Autosomal Dominant Leukodystrophy	341
IV. Molecular Genetics of ADLD	346
V. Molecular Mechanisms of ADLD Duplication Events	347
VI. Molecular Mechanisms Underlying ADLD Disease Pathology	349
VII. Animal Models of Lamin B1 Mutations	351
VIII. Aging and ADLD	352
IX. ADLD and MS	353
X. Summary	353
References	354
Subject Index	359
Volumes in Series	371