# Contents

**Preface** .......................................................... v
**Contributors** ................................................ xi

## Part I Core Techniques

1. Fluorescence *in situ* Hybridization (FISH), Basic Principles and Methodology ... 3  
   *Elisa Garimberti and Sabrina Tosi*

2. Fluorescence In Situ Hybridization on DNA Halo Preparations and Extended Chromatin Fibres ..................... 21  
   *Lauren S. Elcock and Joanna M. Bridger*

3. Detection of Nascent RNA Transcripts by Fluorescence In Situ Hybridization ... 33  
   *Jill M. Brown and Veronica J. Buckle*

4. Fluorescence In Situ Hybridization Analysis of Formalin Fixed Paraffin Embedded Tissues, Including Tissue Microarrays ................. 51  
   *Brenda M. Summersgill and Janet M. Shipley*

5. Fluorescence *in situ* Hybridization (FISH) on Tissue Cryosections ............ 71  
   *Irina Solovei*

6. Multiplex Fluorescence *in situ* Hybridization (M-FISH) .......................... 83  
   *Rhona Anderson*

7. Optical Mapping of Protein–DNA Complexes on Chromatin Fibers ............... 99  
   *Beth A. Sullivan*

8. 3D-FISH on Cultured Cells Combined with Immunostaining ..................... 117  
   *Irina Solovei and Marion Cremer*

## Part II Technical Advancements and Novel Adaptations

9. The Comet-FISH Assay for the Analysis of DNA Damage and Repair ............ 129  
   *Graciela Spivak*

10. Direct In Situ Hybridization with Oligonucleotide Functionalized Quantum Dot Probes .................. 147  
    *Laurent A. Bentolila*

11. LNA-FISH for Detection of MicroRNAs in Frozen Sections ..................... 165  
    *Asli N. Silahtaroglu*

12. Chromosome Orientation Fluorescence In Situ Hybridization or Strand-Specific FISH ........................................ 173  
    *Susan M. Bailey, Eli S. Williams, Michael N. Cornforth, and Edwin H. Goodwin*

13. Combinatorial Oligo FISH: Directed Labeling of Specific Genome Domains in Differentially Fixed Cell Material and Live Cells .............. 185  
    *Eberhard Schmitt, Jutta Schwarz-Finsterle, Stefan Stein, Carmen Boxler, Patrick Müller, Andriy Mokhir, Roland Krämer, Christoph Cremer, and Michael Hausmann*
14 Simultaneous Visualization of FISH Signals and Bromo-deoxyuridine Incorporation by Formamide-Free DNA Denaturation ........................................ 203
   *Daniela Moralli and Zoia L. Monaco*

15 CryoFISH: Fluorescence In Situ Hybridization on Ultrathin Cryosections .... 219
   *Sheila Q. Xie, Liron-Mark Lavitas, and Ana Pombo*

16 Characterization of Chromosomal Rearrangements Using Multicolor-Banding (MCB/m-band) .................................................. 231
   *Thomas Liehr, Anja Weise, Sophie Hinreiner, Hasmik Mkrtchyan, Kristin Mrasek, and Nadezda Kosyakova*

17 Visualizing Nucleic Acids in Living Cells by Fluorescence In Vivo Hybridization .............................................................. 239
   *Joop Wiegant, Anneke K. Brouwer, Hans J. Tanke, and Roeland W. Dirks*

**PART III** TRANSLATIONAL FISH: APPLICATIONS FOR HUMAN GENETICS AND MEDICINE

18 Quality Control in FISH as Part of a Laboratory’s Quality Management System .. 249
   *Ros Hastings*

19 **Flash** FISH: “Same Day” Prenatal Diagnosis of Common Chromosomal Aneuploidies .................................................. 261
   *Sherry S.Y. Ho and Mahesh A. Choolani*

20 FISH for Pre-implantation Genetic Diagnosis ..................................... 269
   *Paul N. Scriven and Caroline Mackie Ogilvie*

21 PNA–FISH on Human Sperm ........................................................... 283
   *Franck Pellestor, Cécile Monzo, and Samir Hamamah*

22 POD-FISH: A New Technique for Parental Origin Determination Based on Copy Number Variation Polymorphism .................................... 291
   *Anja Weise, Madeleine Gross, Sophie Hinreiner, Vera Witthuhn, Hasmik Mkrtchyan, and Thomas Liehr*

23 Sequence-Based High Resolution Chromosomal Comparative Genomic Hybridization (CGH) ................................................ 299
   *Agata Kowalska, Eva Bossaky, and Peter F. Ambros*

24 ImmunoFISH on Isolated Nuclei from Paraffin-Embedded Biopsy Material .... 313
   *Soo-Yong Tan and Goran Mattsson*

25 Fluorescence In Situ Hybridization on 3D Cultures of Tumor Cells ............. 323
   *Karen J. Meaburn*

26 Simultaneous Ultrasensitive Subpopulation Staining/Hybridization In Situ (SUSHI) in HIV-1 Disease Monitoring ......................... 337
   *Bruce K. Patterson*

**PART IV** PROTOCOLS FOR MODEL ORGANISMS

27 Detection of Prokaryotic Cells with Fluorescence In Situ Hybridization .......... 349
   *Katrin Zwirglmaier*

28 FISH as a Tool to Investigate Chromosome Behavior in Budding Yeast ........ 363
   *Harry Scherthan and Josef Loidl*

29 FISH on Chromosomes Derived from the Snail Model Organism *Biomphalaria glabrata* ....................................................... 379
   *Edwin C. Odoemelam, Nithya Raghavan, Wannaporn Ittiprasert, Andre Miller, Joanna M. Bridger, and Matty Knight*
30 Fluorescence in situ Hybridization with Bacterial Artificial Chromosomes (BACs) to Mitotic Heterochromatin of Drosophila. .......... 389
  Maria Carmela Accardo and Patrizio Dimitri

31 Three-Dimensional Fluorescence In Situ Hybridization in Mouse Embryos Using Repetitive Probe Sequences ......................... 401
  Walid E. Maalouf, Tiphaine Aguirre-Lavin, Laetitia Herzog, Isabelle Bataillon, Pascale Debye, and Nathalie Beaujean

32 Fluorescence in situ Hybridization (FISH) for Genomic Investigations in Rat .... 409
  Andrew Jefferson and Emanuela V. Volpi

33 Fluorescence In Situ Hybridization on Early Porcine Embryos ............. 427
  Helen A. Foster, Roger G. Sturmey, Paula J. Stokes, Henry J. Leese, Joanna M. Bridger, and Darren K. Griffin

34 FISH on 3D Preserved Bovine and Murine Preimplantation Embryos ......... 437
  Daniela Koehler, Valeri Zakhartchenko, Nina Ketterl, Eckhard Wolf, Thomas Cremer, and Alessandro Brero

Index ............................................................... 447