

PREFACE

Understanding biology at a cellular and molecular level is an important challenge for the coming century. Biological systems can be incredibly complicated and sophisticated, with many processes occurring simultaneously. Powerful tools will be needed to manipulate and test interacting cells and biomolecules, and to observe their behavior.

Microfluidic chips are well suited to these tasks – they provide a biocompatible environment for cells in a fluid with the proper surfaces, held at the right temperature. Using microchannels, one can sort or assemble cells according to their characteristics, and perform chemical tests. Advances in microfluidics are very promising for biology and medicine.

The complexity of biological systems and their parallel nature is well matched to integrated circuits. The CMOS industry produces programmable microprocessors containing over a hundred million transistors that operate at GHz speeds, as well as high-resolution displays and imaging chips. One can adapt the power of CMOS chips to biotechnology by joining the integrated circuit with a microfluidic system to form a hybrid chip. In this way, one can control the position of cells or biomolecules in fluid using spatially patterned electromagnetic fields, and sensitively sense their response for observations and tests.

The aim of the book is to explore this powerful new approach for biotechnology where the sophistication of CMOS integrated circuits is joined with the biocompatibility of microfluidic systems. Broad research activities of high current interest are covered, with each chapter contributed by experts in the field. We hope that the volume will provide a timely overview of the exciting developments in this nascent field, serving as a springboard for readers to join in.

This book is the culmination of the concerted effort from many people. First and foremost, we thank all the participating authors for their invaluable contributions. Our deep gratitude goes to Professor Chandrakasan at MIT for his helpful suggestions and W. Andress at Harvard for his kindhearted advice. We also gratefully acknowledge the support by Springer, especially from C. Harris and K. Stanne. Last but not least, we give our sincere thanks to our families for their patience and encouragement during the preparation of the book.

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