

# **Preface**

## **Nature of This Book**

This book is a comprehensive and integrated textbook about systems approaches to cancer biology, bioinformatics and medicine, aimed at students, researchers and clinicians, that documents and builds upon many of the most recent advances in cancer science, technology, diagnosis, treatment and analysis methods. These approaches are applied to central processes in cancer origins and progression, and to translational applications including cancer diagnosis, drug development and treatment. The methods involve at least some level of computational analysis involving multiple interactions which are quantified, classified, analysed and modelled for optimized description. New genomic and proteomic measurements and cancerous phenotypes are causally linked (or capable of being so) at the molecular, cellular and tissue levels; research is directly and functionally connected with outcomes, using clinical observations as immediate feedback and input. Computational models of primary and secondary networks at the molecular and physiological levels can serve as test beds for developing and testing new biomarkers, drugs and treatment strategies, and enhance the efficiency, coherency and economy of the pre-clinical test phase and clinical trials.

These approaches transform fragmented investigations into integrated pipelines of research, discovery, monitoring and treatment, based on a quantitative understanding of various cancer mechanisms and their behaviour. Systems approaches thereby energize translational research, where fundamental knowledge of key processes is applied to clinical practice and personalized medicine.

## **Authors, Level of Presentation and Readership**

Many of the 48 authors from 11 countries are world-renowned scientists, clinicians and organizational leaders in their fields, some of which they founded. Their chapters contain comprehensive presentations, pragmatic tools, guidance and inspiration for transforming cancer research and therapy, together with thousands of experimental, computational and clinical references.

The book is designed as a textbook for graduate students in their first and second year of PhD or MD studies and sufficiently advanced undergraduates in life sciences, biomedical and medical studies. It is also a comprehensive reference and survey for professional researchers of cancer systems approaches. Readers without a mathematical background can still benefit from most of the contents, which will allow them to understand the field, and to work closely with computational experts. In fact, independently of the systems aspects, a state-of-the-art description is provided of cancer as a multi-faceted disease, along with relevant research, diagnosis and treatment, so computational biologists will gain the biological and clinical background necessary for effectively working in cancer research. Doctors, clinicians, and university and industrial researchers will find essential references for their investigations and new directions in therapies.

## **Organisation and Contents**

The book has a logically-developed, integrated and cross-referenced presentation, and contains (by chapters):

### **Part I—Introduction and Background**

1. An overview of the topics covered in the book with a general introduction to the basis of systems biology, bioinformatics, and medicine approaches.
2. The morphology and pathology of the full range of cancers, including their grade and stage, plus the most prevalent cancers, their specific sub-classifications, implications for treatment, and the need to move to a systems context.

### **Part II—Laboratory, Clinical, Data and Educational Resources**

3. Major advances in genomic and proteomic measurement technologies and their application to cancer research in the context of numerical modelling.
4. Cellular and tissue material essential for cancer research, model organisms and their modifications, and means of making optimum choices for elucidating biological function in cancer.
5. A wide range of genomic sequence and expression databases which form the basis of systems research in cancerous processes, and some major collaborative efforts in data generation.
6. Interdisciplinary skills for researchers and doctors, along with the educational processes and infrastructures that support basic investigations and clinical applications.

### **Part III—Bioinformatics and Systems Biology Analysis**

7. A comprehensive description of the mathematical basis for systems approaches and their areas of application.
8. A guide to the wide range of computational tools and databases available and how to access and use them optimally.

9. Cancer progression in a systems context via modelling methods, demonstrating the power of these techniques.
10. Cellular pathways of cell-death processes and their relation to various cancer progression modes and interactions with therapies, also illustrating the benefits of collaborative and interdisciplinary research.
11. The utilization of gene expression data and biological motifs for diagnosis and analysis of tumour growth.
12. Evolutionary paradigms used to examine novel systems approaches to understanding tumour growth and reaction in the presence to treatment and bodily defences.

#### **Part IV—Diagnosis and Treatment Applications**

13. Biomarker development for diagnosis, prognosis and drug development, and their identification and correct interpretation to aid therapy.
14. Systems approaches for improving productivity and understanding at several stages in the drug development process, with examples of their use by the pharmaceutical industry.
15. Cancer chronotherapy and choices of combination therapies, dosage and timing, improving treatment outcomes during clinical trials, and computational frameworks for optimization of these choices.
16. An overview and synthesis of systems approaches to biomarkers, drug development and therapies, together with new directions concerning their application to clinical trials.
17. The role of robustness in understanding cancer as a systems disease, resistance to therapy, and new treatment paradigms.

#### **Part V—Perspectives and Conclusions**

18. Near and medium term prospects for advances in systems applications, and areas for progress, especially the application of synthetic biology technologies.
19. Conclusions from each chapter, integrated themes found in the book, and avenues for clinical practice.

Cancer Systems Biology, Bioinformatics and Medicine  
Research and Clinical Applications

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