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# Modelling in Medicine and Biology VI

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## Preface

This book contains the papers presented at the “Sixth International Conference on Modelling in Medicine and Biology” (Biomedicine 2005) held at Bologna in September 2005, and organized by the Department of Electronics, Computer Science and Systems, University of Bologna, Italy, and the Wessex Institute of Technology, Southampton, UK.

Mathematical models and computer simulation techniques have been playing an increasing role in biological and medical research during the last decades, and their impact is certainly going to increase further in future years. There are several reasons which make models so important in medicine and biology. First, biological systems are exceptionally complex, including aspects such as redundancy, non-linearities, hierarchical organization, mutual interconnections among different parts, individual variability. All these aspects, and many others not mentioned here for the sake of brevity, make very difficult to reach a comprehensive understanding of their working in purely qualitative terms. We claim that, the higher the complexity of a system, the more important the role that mathematical models and computer simulation techniques should play to reach a definite appreciation of its behavior.

A second fundamental aspect is the sophistication of the biomedical instrumentation available today. Modern instruments, in the most different clinical fields, now allow simultaneous monitoring of different quantities, and integration of anatomical, metabolic and functional aspects into a comprehensive vision. A complete exploitation of all this information, and its coherent integration may be strongly improved by mathematical models and computer support. Computers are becoming essential parts of the present medical instrumentation, and the core of these programs should be based on a definite modelisation of the system under study.

Finally, diagnostic procedures are becoming increasingly complex, requiring processing of multiple data, often with different physiological meaning, and sophisticated decision algorithms. Mathematical models are becoming essential parts of many diagnostic procedures, and this aspect may become a target of future modeling efforts.

According to the previous overview, there are several essential benefits that mathematical models can offer to biological and medical research. They may improve out basic knowledge of many physiological systems, may contribute to the development of new diagnostic and therapeutic tools, and to the design of innovative instrumentation. These advancements interest a broad spectrum of medical/clinical

subjects: cardiovascular systems and fluid dynamics, neural systems and neuroprosthesis, artificial organs, surgery, orthopedics, imaging, etc. The papers presented in this book, coming from the research activity of several different groups located all over the world, represent a good although not exhaustive example of the possibilities offered by computational modeling in the present medical activity. The subjects of these papers range from basic science (i.e., a comprehension of the system working) to the design of instrumentation, from advanced diagnostic procedures to prosthesis design. In order to facilitate the consultation of the book by experts in different fields, the papers have been arranged in sessions according to their main biological or medical application. The sessions cover: simulation of physiological processes, cardiovascular system, neural systems, biomechanics, computational fluid mechanics in biomedicine, orthopaedics and bone mechanics, simulations in surgery, advanced technology in dentistry, data acquisition and analysis, image processing.

The Editors wish to thank the authors for their excellent contributions, and the members of the international scientific advisory committee for their valuable support. We expect that this book may widen attention of the scientific community into this new and rapidly expanding field, by improving awareness of medical professionals on the benefits that computer simulations may produce in their daily work. Finally, we wish to underline that development of biomedical models requires a multidisciplinary effort, including expertise from different subjects, such as engineering, mathematics, physics, medicine, biology, informatics. This is a very exciting and stimulating aspect of this activity, in an epoch in which specialization and a lack of synthetic attitudes are becoming a characteristic, and sometimes a limitation, of the present scientific thought.

The Editors  
Bologna, 2005

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