Introduction

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The publication of this Theme Issue of CAIM is motivated by two reasons. The first one is our intention to disseminate to a larger public the oral contributions to two mini-symposia organized within the framework of SIMAI 2014. These presentations were characterized by a high quality in terms of sophisticated models, innovative methods, variety of themes, and advanced applications and therefore, at the end of the conference, both SIMAI and CAIM encouraged the publication of original contributions inspired by such talks in the form of scientific articles.

The second reason is related to the impressive development that the use of mathematical formalization and numerical computation have determined in the comprehension of specific physiological mechanisms and in the formulation of modern diagnostic and prognostic paradigms. Mathematical models are nowadays at the very basis of the most accurate descriptions of several complex systems in biomedicine, ranging from tumor angiogenesis, through the cardiovascular apparatus up to neural networks. On the other hand, most modalities currently utilized in clinical diagnostics rely on the numerical solution of imaging problems whose correct, exhaustive, and reliable interpretation still represents a challenging open issue.

The invitation to contribute to this Theme Issue of CAIM devoted to “Mathematical Models and Methods in Biology, Medicine and Physiology” was initially sent to the speakers of the meeting. Subsequently, this same invitation was extended to young Italian mathematicians and computational scientists, in order to support the participation of the new generation of Italian researchers to this exciting area of applied mathematics.

Although not numerous, the contributions to the volume provide an overview of some of the hot topics concerning the use of mathematical models and methods in biology, medicine, and physiology. These papers study the identification of functional connections between signals reflecting neural activity and the way information is processed in the neural circuits (Aletti et al); the formulation and reduction of a mathematical model for rheumatoid arthritis (Matteucci and Nucci); the dynamic modelling of neural sources by using neurophysiological signals (Pascarella and Pitoli); the use of numerical optimization for the calibration of a device for functional neuroimaging (Vivaldi et al.); the numerical reduction of a compartmental model describing tumor hypoxia (Garbarino and Caviglia); a comparison between two models describing cancer invasion in the surrounding tissue (Scianna and Colombi). We believe that the nicest aspect of these contributions is their common perspective of addressing these crucial problems in biomedicine combining profound mathematical knowledges with the ability of interacting with physiologists, clinicians, and bioengineering within a methodological framework of a notable interdisciplinary flavor.

We would like to thank all these authors for their valuable contribution to the realization of this Theme Issue: without their effort this volume would have never been published.