CONTEMPORARY MATHEMATICS

628

Biological Fluid Dynamics: Modeling, Computations, and Applications

AMS Special Session
Biological Fluid Dynamics: Modeling, Computations, and Applications
October 13, 2012
Tulane University, New Orleans, Louisiana

Anita T. Layton
Sarah D. Olson
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Preface

This volume is a result of a special session at the AMS Fall Southeastern Sectional Meeting, which was held at Tulane University in New Orleans, LA, October, 2012. That special session was focused on simulating the motion of an incompressible fluid driven by flexible immersed structures. Active biological tissue is typically constructed of fibers that are surrounded by fluid; the fibers not only hold the tissue together but also transmit forces that ultimately result in fluid motion. In other cases, the fluid may flow through flexible conduits such as blood vessels or airways that both react to and affect the fluid dynamics. Additional examples arise in the context of external fluid flows in biological and engineering applications, such as the dynamics of insect wings, flagellated or ciliated organisms, suspensions of blood cells and other synthetic particles. In addition to solving biologically motivated questions, there is tremendous interest in the development and application of advanced computational techniques to solve these fluid-structure interaction problems.

Given the widespread interest among mathematicians, biologists, and engineers in fluid-structure interaction problems, we believe that this volume is both timely and valuable; this is particularly true because of recent algorithmic improvements. The focus of this volume will be on three main themes: (i) formulation and analysis of mathematical equations that describe fluid-structure interactions in biological systems, (ii) algorithmic and computational issues related to increasing accuracy and efficiency through use of adaptivity, time-stepping scheme, and regularization, and (iii) applications to problems in biological and physical sciences, and interpretation of model results.

This volume is organized as follows. It begins with two review articles that discuss the numerical and computational aspects of fluid-structure interaction problems. Specifically, these articles focus on the mathematical equations describing the fluid and structure, as well they describe state of the art computational approaches to solve the coupled system of equations. Next are original articles that study small-scale fluid motion driven by cilia and flagella. Biological questions are addressed in terms of transport of fluid as well as the development and extension of new numerical methods. Also included are articles that consider a wide variety of physiological examples, including peristalsis, platelet adhesion and cohesion, upside-down jellyfish, and dynamics in the rat kidney.

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This volume contains the Proceedings of the AMS Special Session on Biological Fluid Dynamics: Modeling, Computations, and Applications, held on October 13, 2012, at Tulane University, New Orleans, Louisiana.

In recent years, there has been increasing interest in the development and application of advanced computational techniques for simulating fluid motion driven by immersed flexible structures. That interest is motivated, in large part, by the multitude of applications in physiology and biology. In some biological systems, fluid motion is driven by active biological tissues, which are typically constructed of fibers that are surrounded by fluid. Not only do the fibers hold the tissues together, they also transmit forces that ultimately result in fluid motion. In other examples, the fluid may flow through conduits such as blood vessels or airways that are flexible or active. That is, those conduits may react to and affect the fluid dynamics.

This volume responds to the widespread interest among mathematicians, biologists, and engineers in fluid-structure interactions problems. Included are expository and review articles in biological fluid dynamics. Applications that are considered include ciliary motion, upside-down jellyfish, biological feedback in the kidney, peristalsis and dynamic suction pumping, and platelet cohesion and adhesion.

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