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BOOK REVIEW

Modeling and Simulation of Capsules and Biological Cells. Edited by C. Pozrikidis. Chapman and Hall/CRC, 2003. 344 pp. ISBN 1 58488 359 6. £66.99 or $99.95.

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Modelling and Simulation of Capsules and Biological Cells is a collection of six contributed chapters that is intended to provide a fairly concise overview of the current state of the art in selected topics. The work is intended to act both as a stand-alone reference, and as a starting point for researchers interested in learning more about the field. It is both timely, in view of the rapidly growing interest in modelling flow–structure interaction at the cellular level, and relatively approachable, being generally well written and concise.

The first introductory chapter by D. Barthes-Biesel outlines the mechanics and constitutive laws for membranes and the experimental determination of membrane properties. Results of small-deformation theory for a capsule in shear flow, and a summary of numerical simulations for large deformations is given. The second chapter comprises a clear exposition of shell theory applied to membrane deformation and bending by C. Pozrikidis, ending with a summary review of alternative discrete and variational formulations. As a minor criticism, from the perspective of a student it seems odd not to start with this chapter, since some of the basic equations presented in the introductory chapter rely on concepts first presented at this point.

The third chapter by N. N'Dry and collaborators outlines methods for modelling the rolling of cells adhering to the walls of arteries, e.g. using the immersed boundary technique coupled with simple kinetics relations for the formation and dissociation of adherent bonds. The treatment is relatively cursory for such a complex interdisciplinary subject, but does serve as a useful introduction.

The mechanics of red blood cells and flow in narrow tubes is the topic of the next chapter by T. W. Secomb. Significant phenomena, such as tank-treading of the membranes of red blood cells suspended in a shear flow, the deformation of red blood cells flowing through capillaries smaller than their diameter, the Fåhraeus–Lindqvist effect (where the apparent viscosity of blood in a micro-vessel drops, largely due to migration of cells away from the wall) are described, and references to modelling approaches are provided. A more detailed account of these modelling approaches, particularly with regard to the glycocalyx layer (which is only tangentially alluded to) would have been very welcome, even at the cost of a significantly lengthier chapter.

Capsule dynamics and interfacial transport is presented in chapter five by A. Nir & O. M. Lavrenteva. This and the subsequent chapter on the motion of capsules in tubes and channels by A. Borhan & N. R. Gupta are less condensed than the preceding articles, providing space for more detailed treatments on two particular aspects of the dynamics of capsules in a flow. The boundary integral formulation for the thermocapillary motion of a drop is outlined in sufficient depth to discuss singularity subtraction. The chapter covers the interaction of drops at close proximity, including effects of deformability.

In the final chapter, the basic equations for the motion of capsules in tubes and in a parallel channel (Hele-Shaw flow cell with gap much smaller than capsule radius) are presented. Alternative models for membrane elasticity are summarized and results of investigations on the effects of temperature- and surfactant-induced elasticity are given.

In conclusion the book serves effectively as a means of providing a rapid overview of a number of important areas in the modelling of cells, particularly biological cells in the cardiovascular system. There are some inevitable weaknesses, where the effort to constrain the overall length whilst providing a broad overview has resulted in the omission of substantial detail. Overall though the book satisfies the stated objectives, which are to act both as reference and an introductory text, and it is to be recommended.

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