Preface

This volume consists of Lecture Notes based on lectures delivered at the Advanced Summer School entitled "The Role of Mechanics in the Study of Lipid Bilayers" held at the International Centre for Mechanical Sciences (CISM) in Udine, Italy, during the period July 11–15, 2016. The course was presented by six lecturers, from Germany, Mexico, Spain, the UK and the USA (2).

The purpose of the six chapters comprising the volume is to provide a state-of-the-art account of the continuum theory underpinning the mechanics and physics of lipid bilayers and its applications.

Chapter "Mechanics and Physics of Lipid Bilayers" outlines an approach to the theory of lipid bilayers through an appeal to three-dimensional liquid-crystal theory. This provides an over-arching framework that encompasses the classical theory while facilitating its extension to embrace nonstandard effects associated with lipid tilt and distension, dissipative processes involving flow and diffusion, and electromagnetic interactions.

Chapter "Elasticity and Hereditariness" is devoted to the study of the energetics of lipid membranes, the nature and origin of the line tension accompanying phase transitions, and the role played by viscoelastic effects.

Chapter "Lipid Membranes: From Self-Assembly to Elasticity" delves into the physical basis of lipid bilayer arrangements, their self-assembly and associated thermodynamics, their elastic moduli, and the physical origins of lipid tilt.

In Chapter "The Geometry of Fluid Membranes: Variational Principles, Symmetries and Conservation Laws" the theory of lipid membranes is cast in a variational and differential-geometric setting, facilitating a development of the notion of membrane stress and its role in the associated mathematics. Included here are the consequences of reparametrization invariance and Euclidean invariance and the systematic treatment of constraints.

Chapter "On the Computational Modeling of Lipid Bilayers Using Thin-shell Theory" is devoted to the numerical analysis of lipid membrane behavior by advanced finite element methods. This provides an opportunity, through several examples, to exhibit the potential of the theory of lipid bilayers to predict of the emergence of various geometric features such as filaments and buds.

Chapter "Onsager's Variational Principle in Soft Matter: Introduction and Application to the Dynamics of Adsorption of Proteins onto Fluid Membranes" describes a far-ranging investigation into Onsager's variational principle with applications to chemo-mechanical problems in soft matter and the dynamics of protein adsorption.

These chapters combine to provide a unique perspective on this important branch of bio-physics from the vantage point of mechanics and applied mathematics.

It is a pleasure to acknowledge the efforts of my colleagues, Profs. Arroyo, Deseri, Deserno, Guven and Sauer, for presenting their lectures and for preparing the chapters of this volume, and the students for attending the lectures and contributing to the discussions.

I particularly thank the Rector, officers and staff at CISM for their encouragement, enthusiasm, assistance, and warm hospitality, which were essential to the success of the School. I am also grateful to Prof. Paolo Serafini, Executive Editor of CISM, for his guidance and encouragement in the preparation of these lecture notes.

Berkeley, USA David J. Steigmann

Springer

http://www.springer.com/978-3-319-56347-3

The Role of Mechanics in the Study of Lipid Bilayers
Steigmann, D.J. (Ed.)
2018, VII, 332 p. 72 illus., 30 illus. in color., Hardcover
ISBN: 978-3-319-56347-3