Preface

> (. . .) the quest for an answer to the riddle, "What is Life?" is one of the grand themes that resonate through the scientific conversation of this century (. . .). That riddle embraces and transcends the subject matter of all the biological sciences, and much of physical science as well. A physics that has no place for life is as impoverished as would be a biology not informed by chemistry. The study of life as a natural phenomenon, a fundamental feature of the universe, must not be allowed to slip into the black hole of departmental tribalism.
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> Franklin M. Harold (2001)

The great successes of science in the last one and a half century built a strong conviction that chemical reactions and interactions between molecules lie at the basis of life. Starting with physiological chemistry, through biochemistry and physiology, up to molecular biology, -omics, systems biology, and now also synthetic biology, they all provided a very detailed picture of the chemical nature of cells and organisms. Only in some areas of natural sciences, the emerging data were suggesting that biology means more than chemistry itself. Electrophysiology, bioenergetics, the phenomenon of photosynthesis on one side, and the properties of wood, cotton fibers, silk, or spiderweb as construction and engineering materials on the other, are only a handful of such cases. Research of recent years, however, is more and more evidently indicating that physical forces are profoundly affecting the functioning of life at all levels of its organization. To detect and to respond to such forces, cells and organisms, among them plants, need to be organized physically, and mechanically in particular (Wang et al. 2009). Although the structure–function relationship is studied for decades at all levels of hierarchical organization, the knowledge about its physical aspects is still in the making. Macromolecular crowding, the importance of electrical forces, regulation of molecular machineries via structural organization of cellular compartments, direct mechanical connections between the interior and peripheries of the cell, cellular adhesion, and mechanical integration of cells within multicellular organism are examples of the recently investigated processes with strong physical side. Due to historical reasons, and also significant medical potential, the importance of mechanical environment on the functioning/fate of the cells is becoming very well recognized in animal cell biology, and also for bacterial cells. The least documented are the mechanobiological phenomena in plant cells and plants itself. The interplay between cell walls and the turgor pressure, the basis for creation of the biggest organisms on Earth, is on the other hand the major barrier in revealing the mysteries of the structural and functional integrity of the cells.

The mechanical aspects of plant life could be analyzed at many different levels of hierarchical organization. Here, we are trying to demonstrate how the awareness of the physical side of life is affecting the interpretation of biological phenomena. This book gathers contributions from many authors describing the importance of mechanical forces/stimuli for or mechanical organization of (1) supramolecular structures, like the cytoskeleton or cell walls; (2) cellular integrity, like cytoplasmic streaming and movement of organelles; (3) supracellular coordination in the processes of plant organ growth and development; (4) integration of plant functioning, e.g., in long-range water transport or plant responses to physical forces or environmental stimuli. The chapters are organized in a way to give the reader the possibility to travel along the ladder of hierarchical levels in a bottom-up approach, i.e., from molecules through cells and organs, and up to plants interacting with their immediate neighborhood or responding to stresses. Thus, the book covers all the major aspects of mechanobiological phenomena, providing also direct or indirect evidence for the organismal nature of plants – a feature which could only very rarely be seen in multicellular animals.

Immanuel Kant, in his *Metaphysische Anfangsgründe der Naturwissenschaft* (1786), noted "(...) in any special doctrine of nature there can be only as much *proper* science as there is *mathematics* therein". Using this saying, one can observe that in any biological process there might be only as much freedom as the physical laws would allow. Mechanical integration of living cells and organisms constitutes a visible expression of the unity and intertwining connections between the living and inanimate parts of nature.

Poznań, January 2011 Przemysław Wojtaszek

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Springer
http://www.springer.com/978-3-642-19090-2

Mechanical Integration of Plant Cells and Plants
Wojtaszek, P. (Ed.)
2011, VIII, 352 p., Hardcover
ISBN: 978-3-642-19090-2