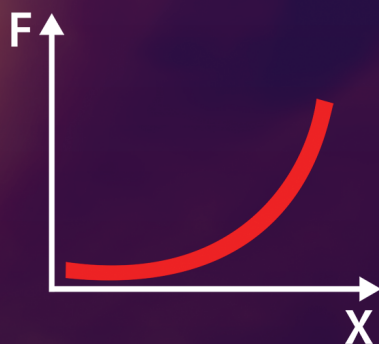


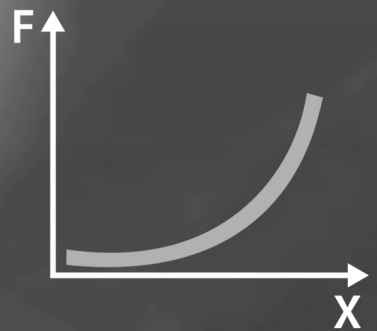
# Cellular Analysis by Atomic Force Microscopy

Malgorzata Lekka





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## Preface

In the recent two decades, there has been ample evidence that shows the capability of detecting pathologically changed cells basing on their mechanical properties. Such studies commenced to be attractive for biology and medicine with the development of techniques enabling the measurements at a single-cell level. One of such techniques is atomic force microscopy (AFM). Despite evidence showing the feasibility of AFM to identify cells with altered elastic and adhesive properties, the use of this technique as a complementary diagnostic method, for example, in cancer treatment, raises a lot of controversy. This is primarily due to the still high complexity of the apparatus, the complexity of the experiment and data analysis, and the lack of basis for the rapid verification of the results. In addition, there are also doubts whether a high sensitivity of the method (measuring the properties of a single cell) will be sufficient to validate the cancer cell identification at the same level as it is carried out in the analysis of aspirate composed of millions of cells at different stages of progression.

The monograph *Cellular Analysis by Atomic Force Microscopy* presents the use of the AFM as a tool for the characterization of cancerous cells by studies of cellular deformability and cells' adhesive properties. The text is organized as follows: after a brief introduction pointing out the significance of cellular deformability and adhesive properties, Chapter 2 shortly discusses the basic elements of the cell structure, on the knowledge level that facilitates understanding of the role and significance of mechanical properties in cancer. Chapter 3 is devoted to the AFM technique itself. It covers the description of the idea and the construction details of the atomic force microscope, introduces the force spectroscopy mode of its operation, and discusses the calibration issues. The next two chapters are focused on specific applications: Chapter 4 is devoted to cellular deformability measurements by the AFM and Chapter 5 introduces the technique for quantification of cellular adhesive properties. The monograph concludes with

Final Conclusions, briefly summarizing the use of atomic force microscopy in cancer research.

This monograph\* is designed to be a kind of a practical textbook, presenting in a concise manner the methodology of assessing the mechanical characteristics of individual cells by AFM. It is addressed to those researchers who need some hints in cases when strange results came out from the AFM experiment. I hope that the monograph will help eliminate at least some questions.

I would like to dedicate this book to all people who helped me in different ways in my research. I am taking this moment to express my deep gratitude to all of them. In particular, I would like to mention Zbigniew Stachura (IFJ PAN), who was always ready to answer questions and give invaluable advice, and whose continuous support enabled to establish and organize the biological activity of the AFM laboratory; Piotr Laidler (CM UJ) for teaching me how to understand biological phenomena, for his help during the realization of my biological experiments, and, most important, for showing me the importance of my studies; Jan Styczeń (IFJ PAN) for his support and for encouraging me in my studies over many years during his heading of the former Department of Nuclear Spectroscopy. I would like to also acknowledge Joanna Wiltowska-Zuber (IFJ PAN) for her invaluable help with managing the AFM laboratory, especially during the time when I was writing this monograph. Finally, I would like to thank my whole family and especially my husband, Janusz, for continuous support.

The topics of this book were also conceived within the networking research activity of the EU COST Action on Applications of Atomic Force Microscopy to NanoMedicine and Life Sciences (AFM4NanoMed&Bio) and the NCN project number NCN DEC-2011/01/M/ST3/00711.

**Małgorzata Lekka**

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\*A large portion of the this book has been prepared on the basis of my IFJ PAN Report, 2001/AP entitled "The use of atomic force microscopy as a technique for the identification of cancerous cells."