

Final report concerning the workshop

## **Physical principles of protein behavior in the cell (PHPPBC09)**

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The workshop, which took place on 26-30 October 2009, was concerned with the problem of understanding the physical principles that govern the behavior of proteins in the cell. This theme is relevant since proteins are involved in essentially all of the biochemical reactions that take place in living organisms, including those required for the control of gene expression, metabolism, transport, and enzymatic catalysis. The workshop was inspired by the realization that the mechanisms of protein regulation are being elucidated at an increasing pace, and many advances have been made in our understanding of how protein concentrations, localizations, and interactions are controlled within living cells. The introduction of novel experimental high-throughput techniques and of theoretical analysis methods have enabled the initial study of the networks of interacting molecules that underlie the functioning of the myriad biological pathways through which cells maintain homeostasis and promote development. Considering these advances we decided that it was timely to organize a meeting to discuss current achievements and future directions.

Our workshop had a distinctly interdisciplinary character and brought together researchers from the major areas relevant to understanding protein behavior in the cell, including protein expression, transport, localization, function, folding, misfolding, and aggregation. As a consequence, synergies between experimental, theoretical, computational, and statistical approaches were anticipated

on two main fronts: to improve our understanding of the physico-chemical basis of protein behavior, and to suggest new methods for predicting and modulating it. Achieving these synergies will help provide an integrated view of the subject, and the workshop stimulated such developments by exploring the connections between different fields and by providing a suitable framework for exchanging ideas and methods. Our primary aim was to probe in depth the idea that further understanding of the physical principles that underlie protein behavior in the cell can greatly improve existing methods for characterizing and predicting structures, interactions, and functions of proteins, for modeling their evolution, and ultimately for suggesting new rational approaches for treating human diseases.

The workshop has been organized in topical sessions, ‘Proteomics I and II’ (R. Aebersold, K. Büssow, M.B. Mohan, P. Schwill, K. Lilley, M. Mann, and S. Brunak), ‘Protein evolution’ (E. Shakhnovich), ‘Modeling cell behavior’ (S. Grill, G.G. Tartaglia, and H. Bussemaker), ‘Protein folding and misfolding I and II’ (J. Frydman, S. Ventura, D. Müller, and A. Horovitz), ‘Protein interaction’ (P. Aloy, A. Plückthun, M. Schroeder, and J. Colinge), and ‘Protein expression’ (N. Luscombe, C.O. Wilke, R.N. Day, and E. Marcotte). Besides the contributions of the invited speakers, the workshop has also benefited from the very high level contributions by non-invited participants, both in the form of short oral presentations as well as in the poster sessions. The friendly and communicative atmosphere that developed from the very beginning favored the discussions, which was also facilitated by the fact that most talks contained references to the work of other participants.

One interesting additional outcome of the workshop has been to identify in a broad sense how Physics can contribute to Biology: (1) By developing new techniques. Standard methods such as X-ray crystallography and NMR spectroscopy have been developed in this way. More recently, and related to the theme of this meeting, mass spectroscopy and various types of imaging techniques. (2) By developing new statistical methods of data analysis. (3) By formulating models and theories to rationalize existing experimental observations and to propose new experiments.

Participants’ reactions to our efforts to integrate the so far separated disciplines into a single workshop, and possibly into a common scientific community, have been unanimously enthusiastic. We plan to publish a selection of peer-reviewed papers in a special issue of an international journal.

The organizers wish to express their sincere gratitude to the MPIPES for hosting and financing this workshop and for the very generous support.