The Sodium Pump

Ernst Bamberg, Wilhelm Schoner
Editors

The Sodium Pump

Structure Mechanism, Hormonal
Control and its Role in Disease

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Preface

The sodium of animal cell membranes converts the chemical energy obtained from the hydrolysis of adenosine 5'-triphosphate into a movement of the cations Na^+ and K^+ against an electrochemical gradient. The gradient is used subsequently as an energy source to drive the uptake of metabolic substrates in polar epithelial cells and to use it for purposes of communications in excitable cells. The biological importance of the sodium pump is evident from the fact that between 20–70% of the cell's metabolic energy is consumed for the pumping process. Moreover, the sodium pump is an important biological system involved in regulatory processes like the maintenance of the cells' and organism's water metabolism. It is therefore understandable that special cellular demands are handled better by special isoforms of the sodium pump, that the expression of the sodium pump and their isoforms is regulated by hormones as is the activity of the sodium pump via hormone-regulated protein kinases. Additionally, the sodium pump itself seems to be a receptor for a putative new group of hormones, the endogenous digitalis-like substances, which still have to be defined in most cases in their structure. This group of substances has its chemically well known counterpart in steroids from plant and toad origin which are generally known as "cardiac glycosides". They are in medical use since at least 200 years in medicine in the treatment of heart diseases.

Since the first description of the sodium pump's enzymological equivalent, Na^+/K^+ -ATPase, the study of this membrane protein has attracted a still increasing number of scientists because the sodium pump is used as a model system to understand the molecular events of the conversion of chemical energy into the vectorial process of transport. Many attempts have been made to get insight into the structure of the pump, the mechanism of assembly of the subunits and the sorting of the proteins involved into the proper location within the cytoskeleton, the organisation of the gene structure and its regulation of expression. Medical aspects, moreover, like the intentions to understand the role of the pump in sodium, potassium and water metabolism as well as the activity regulation by natriuretic hormones and cardiocative steroids and the therapeutic difficulty in handling these hormones and drugs in disease give still new impacts to the field.

To facilitate the exchange of information, seven international conferences have been held on the subject, the first in 1973 in New York, sponsored by the New York Academy of Sciences; the second in 1978 in connection with Aarhus University, Denmark. Since then it has been a tradition to hold a conference every third year: in 1981 at Yale University, New Haven, Connecticut; in 1984 in Cambridge University, England; in 1987 in Fuglsø again in connection with Aarhus University, Denmark; in 1990 at the Marine Biological Laboratory in Woods Hole, Massachusetts as a meeting of the Society of General Physiologists. The 7th International Conference on THE SODIUM PUMP in 1993 was held from

September 5–11 in Todtmoos, Germany. This conference with almost 250 participants from all over the world was organized as the 105th Conference of the Gesellschaft für Biologische Chemie and was supported financially primarily by the Deutsche Forschungsgemeinschaft, Bonn–Bad Godesberg and the Max-Planck-Gesellschaft zur Förderung der Wissenschaften, München. The generous support by the Deutsche Forschungsgemeinschaft helped a great number of scientists from eastern european countries and the former Soviet Union to attend and to contribute to the conference. The financial support by funds of the Oswald Stiftung des Instituts für physikalische Grundlagen der Medizin, the Gesellschaft für Biologische Chemie, the Giessener Hochschulgesellschaft and the pharmaceutical companies Astra Hässle AB, Mölndal/Sweden, Bayer AG, Wuppertal/Germany, Knoll AG, Ludwigshafen/Germany greatly smoothened problems of organization. On behalf of the organizers, we thank all who took care of the practical arrangements, and those who helped us to run the conference.

The proceedings of all conferences on THE SODIUM PUMP have developed to be a major source of information and reference for people interested in reviews on all aspects of the sodium pump as well for the researcher in the field on detailed questions. With this knowledge in mind, the editors tried to assemble scientists in Todtmoos to review the status of the knowledge in their special field of scientific interest. As will be evident, major progress has been made in the last 3 years in understanding of a number of issues of general importance. The reviews on almost all fields of the topic are commented and supported by extended abstracts of the scientific contributions presented in poster form during the whole week of the conference. They attracted a continuous stimulus for exchange of ideas and further research. The editors hope that reading of reviews and short reports will stimulate further progress in our understanding of structure, mechanism and hormonal control as well as of biological and medical significance of the sodium pump of the mammalian cell.

Ernst Bamberg
Wilhelm Schoner

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