SOZYMES:
ganization
& Roles
olution
enetics &
hysiology

ISOZYMES:
Organization and Roles in Evolution, Genetics and Physiology

Proceedings of the September 6–13, 1992 Congress at Novosibirsk, Russia

The Seventh International Congress on Isozymes

Editors

Clement L. Markert, Ph.D.
Department of Animal Science
North Carolina State University
Raleigh, North Carolina 27695, USA

John G. Scandalios, Ph.D.
Department of Genetics
North Carolina State University
Raleigh, North Carolina 27695-7614, USA

Hwa A. Lim, Ph.D.
Computational Genetics & Biophysics
Supercomputer Computations Research Institute
Florida State University
Tallahassee, Florida 32306-4052, USA

Oleg L. Serov, Ph.D.
Institute of Cytology & Genetics
Russian Academy of Sciences
Siberian Department
630090 Novosibirsk 90, Russia

World Scientific
Singapore • New Jersey • London • Hong Kong

Published by

World Scientific Publishing Co. Pte. Ltd.

P O Box 128, Farrer Road, Singapore 9128

USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661

UK office: 73 Lynton Mead, Totteridge, London N20 8DH

ISOZYMES — ORGANIZATION AND ROLES IN EVOLUTION, GENETICS AND PHYSIOLOGY
(7th International Congress on Isozymes)

ISBN 981-02-1449-9

Printed in Singapore by General Printing Services (Pte) Ltd

ISOZYMES:

Organization and Roles
volution, Genetics and Physiology

Organizing Committee

- Honorary President
  - Dr. Vladimir Shumny
- Co-Chairmen
  - Dr. Leonid Korochkin
  - Dr. Oleg Serov
- Advisory Committee, Chairmen of Previous Congresses
  - K. Gregory
  - F. Wroblevsky
  - E. Vesell
  - C. Markert
  - M. Siciliano
  - J. Scandalios
  - A. Tsaftaris
  - Z. Ogita
- International Committee
  - H. Eppenberger, Switzerland
  - C. Frova, Italy
  - R. Holmes, Australia
  - C. Markert, USA
  - Z. Ogita, Japan
  - J. Scandalios, USA
  - C. Schnarrenberger, Germany
  - A. Tsaftaris, Greece
- Local Organizing Committee
  - L. Korochkin, O. Serov, Co-chairmen
  - Ju. Altukhov
  - Ju. Dubrova
  - V. Kirpitchnikov
  - N. Kolchanov
  - E. Levites
  - N. Mertvetsov
  - A. Pudovkin
  - R. Sukernik

SCRI DIRECTOR'S STATEMENT

It is a great pleasure for the Supercomputer Computations Research Institute (SCRI) to take part in *The 7th International Congress on Isozymes*, held at the House of Scientists, Novosibirsk, September 6–13, 1992.

With this congress and these proceedings, we are certain that we have made significant progress both in advancing the knowledge and further perfecting the tools in this exciting research area. Being a high performance computing institute, our emphasis is on the development of computational techniques and use of computers as tools in scientific, engineering and technological researches. The fundamental belief is that the most efficient mechanism for making computational advances is to have talented computational scientists working in the immediate area of like-minded others in the same or related fields. As a result, SCRI was established in 1984 to encourage interdisciplinary research and cross-disciplinary fertilization of computational techniques using the current generation of high performance computers. The basic theme is that developments in computational science is applications-driven.

The study of isozymes is an excellent example of an interdisciplinary research requiring the utmost in the imagination and expertise of many disciplines. We anticipate that computers, which have permeated almost every facet of our daily life, will play an integral role in the research in the near future. We also hope that in future sequels to the congress, reports on computational work will play a bigger part.

We are pleased to take part in preparing this proceedings volume. We also look forward to playing a major role and making new personal connections in future congresses. Together we will continue to make progress in this very important and exciting field of research.

March, 1994

Dennis W. Duke
Director, SCRI

PREFACE

Since the isozyme concept was formulated some thirty-five years ago, and especially after the advent of transgenic technology, the deep interest in the area has led to thousands of research investigations and many international conferences on the subject. The *7th International Congress on Isozymes*, held at House of Scientists, Novosibirsk, Russia and hosted by the Institute of Cytology and Genetics, Russian Academy of Sciences on September 6–13, 1992, was a sequel to the by now well-known international congresses on isozymes. This is the first time such a congress was held in Russia.

Speakers were leading experts in their respective fields, and participants were from countries like Australia, Belorussia, Canada, China, France, Germany, Greece, Israel, Japan, Russia, Ukraine, USA, and others. This volume is based on selected oral presentations in the Congress. Among some of the key issues and challenges discussed are: isozymes in population and evolution genetics, isozyme markers in gene mapping, isozymes in plant genetics, role of isozymes in normal physiology, the use of isozymes in human population biology, molecular organization and developmental regulation of isozymes and other related topics.

Many of our colleagues put considerable effort into ensuring the success of this congress, and we are very grateful to them. We would also like to thank Academician V.K. Shumny, Director of Institute of Cytology and Genetics, for his support, and acknowlege the contributions of many others too numerous to mention. Thanks also go to Donna E. Burnette and David Poindexter for making these proceedings possible, and Professor Dennis W. Duke, Director of SCRI, whose support and encouragement helped to make the preparation of these proceedings so much easier and smoother.

Last but not least, the organizing committee of the conference also deserve special thanks because, without them, the congress would not have been possible.

March, 1994

C.L. Markert
J.G. Scandalios
H.A. Lim
O.L. Serov

Opening ceremony. Academician V. Shumny, Director of Institute of Cytology & Genetics, addressing the participants. (l to r) Serov, Shumny, Markert and Korochkin.

At the banquet table.

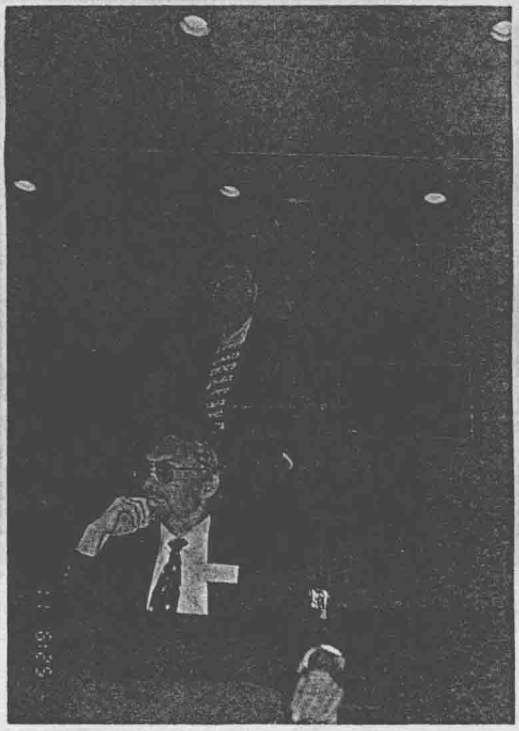
Group photo of conference participants during a picnic on an isalnd on the Ob Sea– a man-made sea.

Mushroom picking on the island.

Waiting to be picked up to return to the mainland after the picnic on the island.

An evening of cultural dance at the Novosibirsk State University.

Business dinner at the Serov's residence. Back row (l to r) Korochkin, Holmes (Chairman of upcoming 8th Congress), Mrs. Serov, Scandalios, Markert; front row (l to r) Lim and Serov.



Closing ceremony. Dr. Markert making the closing remark.

Contents

Part I

Plenary Session

Transgenic Creation of Novel Isozyme Systems for Challenging and Studying the Physiology and Development of Organisms

Clement L. Markert*

* North Carolina State University Raleigh, North Carolina

1.1 Introduction

The study of isozymes has provided new insights into the structure and function of the genome, the regulation of gene function during cell differentiation and development, and specifically into the structure, function, and evolution of isozymes themselves. Although isozymes have always been of basic significance to cell physiology we are only now beginning to exploit our new ability through transgenic technology to create new isozyme systems designed to change cell physiology to suit our experimental goals and also to fulfill many practical purposes in genetic engineering including the cure of genetic diseases.

Before the era of transgenesis we had to rely on naturally occurring isozyme systems to explore their biological significance. The systems revealed by research were adequate initially to keep us challenged but eventually new discoveries waned in number and significance. Now, however, there are virtually no limits. We can make all the isozyme systems we wish. Every gene from any organism, and truly artificial genes manufactured in the laboratory, can now be used by transgenic techniques to equip cells with new genes to make new isozyme systems. Moreover we can place these genes at different places in the genome and also equip them with different ancillary sequences–promoters, enhancers, introns, etc., to regulate the time, place, and quantity of gene activity. We can even transplant whole chromosomes or any fraction of a chromosome and expect to elicit genetic function leading to additional enzyme synthesis and novel cell physiologies.

Of course, most of these transgenically created isozyme systems will not prove beneficial to the cell or to the organism. Any change is likely to prove deleterious. After all, every gene must have been duplicated many times in evolution, but few of the duplications have survived as functioning genes coding for specific enzymes. Evolutionary selection eliminated nearly all these duplications or suppressed them by one cytogenetic mechanism or another. Probably additions to the genome by transgenesis will suffer the same fate, although we can experimentally select to preserve those we wish to survive. In the past only those duplications that produced beneficial isozyme systems survived. Nevertheless such duplications of DNA