Artificial Oxygen Carrier
Its Front Line
Foreword

This volume of the *Keio University International Symposia for Life Sciences and Medicine* contains the proceedings of the 13th symposium held under the sponsorship of the Keio University Medical Science Fund. The fund was established by the generous donation of the late Dr. Mitsunada Sakaguchi. The Keio University International Symposia for Life Sciences and Medicine constitute one of the core activities sponsored by the fund, of which the objective is to contribute to the international community by developing human resources, promoting scientific knowledge, and encouraging mutual exchange. Each year, the Committee of the International Symposia for Life Sciences and Medicine selects the most significant symposium topics from applications received from the Keio medical community. The publication of the proceedings is intended to publicize and distribute the information arising from the lively discussions of the most exciting and current issues presented during the symposium. On behalf of the Committee, I am most grateful to the late Dr. Sakaguchi, who made the series of symposia possible. We are also grateful to the prominent speakers for their contribution to this volume. In addition, we would like to acknowledge the efficient organizational work performed by the members of the program committee and the staff of the fund.

Naoki Aikawa, M.D., D.M.Sc., F.A.C.S.
Chairman
Committee of the International Symposia for Life Sciences and Medicine
Speakers, chairpersons, and discussants at the symposium are identified in the photograph by numbers on the diagram.

44. Prof. Shimizu  45. Prof. Takaori  46. Prof. Fukushima  47. Dr. Dröbin  48. Dr. Alayash  49. Wang  50. Ms. Oguro  
51. Horinouchi  52. Ms. Ohba  53. Dr. Tsai  54. Dr. Hahn  55. Prof. Zapol  56. President Prof. Kobayashi  57. Prof. Chang  
58. Dr. Vandegriff  59. Dr. Baldwin  60. Dr. Silverman  61. Prof. Tsuchida  62. Prof. Winslow  63. Prof. Lundgren  
64. Prof. Suematsu  65. Founder of Keio, Yukichi Fukuzawa  66. The first dean, Prof. Kitasato

*The editors regret that the name was unavailable.
Our understanding of blood has changed considerably since the Middle Ages, when it was regarded with a mixture of fear and superstition. The first successful human transfusion was done by James Blundell in 1818, and in the last century, since Karl Landsteiner discovered blood types, transfusion medicine has evolved to become one of the most important therapeutic modalities today, changing medical practice along the way. However, unexpected side effects such as bacterial and viral infections, immunological disorders, and mismatch transfusion compromise the beneficial results gained through transfusion.

Although every effort has been made to avoid these side effects, we know that blood transfusion still comes with the risk of infectious diseases and adverse reactions. Also, long-term storage and transportation of blood components is still a challenge.

To solve these problems, physicians and researchers have been searching for suitable artificial blood substitutes. The concept of an artificial oxygen carrier was advocated by Michael Heidelberger at the Rockefeller Institute in 1922. Thomas Ming Swi Chang invented the artificial cell in 1957 and demonstrated its medical potential. Since then, hemoglobin-based oxygen carriers have been the mainstream of research, with some even entering clinical application.

Biologically inert oxygen carriers such as perfluorochemicals were studied by Leland Clark in 1957, while Eishun Tsuchida synthesized an oxygen-carrying material using polymer chemistry in 1973. It is hoped that all these endeavors will bear fruit in the near future.

Research into artificial oxygen carriers has generated a spin-off in oxygen therapeutics. Because oxygen is a fundamental molecule in the body, this concept has changed therapeutic modalities. When we can understand gas biology in cells, tissues, and organs, we will be able to open a new era in medicine.
Research into artificial oxygen carriers at Keio University began in 1985 in collaboration with Eishun Tsuchida of Waseda University’s Department of Polymer Chemistry when he developed a totally synthetic oxygen-carrying lipidheme vesicle. Since then, we have developed and evaluated several types of artificial oxygen carriers, assessing their safety, efficiency, and the reactions they generate. Of the techniques explored, we have chosen hemoglobin vesicles and lipidheme vesicles, which are nanocapsule-type artificial oxygen carriers, and the proteomics-type artificial oxygen carrier albumin-hemes as potential candidates for human use. We have been enthusiastically studying these materials and feel they have considerable potential.

Nevertheless, there are still many issues to be solved concerning medical, chemical, physical, industrial, and ethical problems. To enhance research activity, collaboration with international core facilities and conscientious discussion are necessary. In this book, cutting-edge research and development of artificial oxygen carriers are presented.

The Keio University International Symposium for Life Sciences and Medicine is supported by the Keio University Medical Science Fund, founded on donations from the late Dr. Sakaguchi and Mrs. Sakaguchi. I express my deepest appreciation to the founder, and thanks to all fund staff for their unstinting efforts.

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Contents

Foreword ................................................................. V

Preface ................................................................. VIII

List of Contributors ................................................... XIII

Opening Remarks ....................................................... XIV

Safety and Efficacy of Hemoglobin-Vesicles and Albumin-Hemes
K. Kobayashi, H. Horinouchi, M. Watanabe, Y. Izumi, Y. Teramura,
A. Nakagawa, Y. Huang, K. Sou, H. Sakai, T. Komatsu, S. Takeoka,
and E. Tsuchida ......................................................... 1

Red Blood Cell Substitutes: Past, Present, and Future
T.M.S. Chang ............................................................ 22

Inhaled Nitric Oxide: Update 2003
W.M. Zapol .............................................................. 34

The Role of p50 in Tissue Oxygen Delivery by Cell-Free
Oxygen Carriers
R.M. Winslow ........................................................ 38

Repetitive Administration of Hemoglobin Raffimer in Experimental
Models and Clinical Applications
H.W. Kim, G. Biro, and A.G. Greenburg .......................... 53

Oxygen Gradients In Vivo Seen by a High Oxygen Affinity
HB Polymer
E. Bucci and R.C. Koehler ............................................ 62
Oxygen Partition Between Microvessels and Tissue: Significance for the Design of Blood Substitutes
A.G. Tsai, B. Friesenecker, and M. Intaglietta .......................... 70

Endothelial Cell Response to Hemoglobin Based Oxygen Carriers. Is the Attenuation of Pathological Reactions Possible?
J. Simoni ................................................................. 75

The Development of a Second-Generation, Designer, Recombinant Hemoglobin
K.E. Burhop ............................................................ 127

Hemoglobin-Vesicles (HbV) as Artificial Oxygen Carriers
H. Sakai, K. Sou, S. Takeoka, K. Kobayashi, and E. Tsuchida ....... 135

Successful Ex Vivo Normothermic Liver Perfusion with Purely Artificial Products Using Artificial Blood

Effect of Hemoglobin-Based Blood Substitutes on Nitric Oxide Transport: Mathematical Models
A.S. Popel, M. Kavdia, and N.M. Tsoukias ............................. 176

New Strategy for the Preparation of NO-Treated Red Blood Cells as a Blood Substitute
A. Tsuneshige and T. Yonetani ........................................ 186

Oxygen-Carrying Plasma Hemoprotein Including Synthetic Heme
T. Komatsu and E. Tsuchida ........................................... 193

Micromechanical Properties of Newly Developed Polyelectrolyte Microcapsules (PEMC)
H. Bäumler, C. Kelemen, R. Miltöhner, R. Georgieva, A. Krabi, S. Schäling, G. Artmann, and H. Kiesewetter ......................... 205

Intravascular Microbubbles: An Ultra-Effective Means of Transporting Oxygen
C.E.G. Lundgren, G.W. Bergoe, and I.M. Tyssebotn .................. 217

Oxygen-Dependent and Oxygen-Independent Effects of Perftoran
E. Maevsky and G. Ivanitsky ....................................... 221

State of the Art and Challenges in Blood Substitutes Research: A Case Study on Perfluorocarbon-Based Oxygen Carriers
J.C. Briceño ............................................................. 229
XII  Contents

Semifluorinated Alkanes as Stabilizing Agents of Fluorocarbon Emulsions
  S.M. Bertilla, P. Marie, and M.P. Krafft  ......................... 237

Possible Role of Artificial Oxygen Carriers in Shock and Trauma
  B.T. Kjellström ................................................. 252

Clinical Needs for Artificial Oxygen Carriers in Anaesthesia
  R.G. Hahn ...................................................... 259

Studies on Red Cell Substitutes in Japan and Future Perspectives
  M. Takaori .................................................... 267

Key Word Index ................................................ 279
List of Contributors

Artmann, G. 205
Bäumler, H. 205
Bergoe, G.W. 217
Bertilla, S.M. 237
Biro, G. 53
Briceño, J.C. 229
Bucci, E. 62
Burhop, K.E. 127
Chang, T.M.S. 22
Friesenecker, B. 70
Georgieva, R. 205
Greenburg, A.G. 53
Hahn, R.G. 259
Hirata, K. 169
Horinouchi, H. 1
Huang, Y. 1
Intaglietta, M. 70
Isobe, M. 169
Ivanitsky, G. 221
Izumi, Y. 1
Katsuramaki, T. 169
Kavdia, M. 176
Kelemen, C. 205
Kiesewetter, H. 205
Kikuchi, H. 169
Kim, H.W. 53
Kimura, H. 169
Kjellström, B.T. 252
Kobayashi, K. 1, 135
Koehler, R.C. 62
Komatsu, T. 1, 193
Krabi, A. 205
Krafft, M.P. 237
Kukita, K. 169
Lundgren, C.E.G. 217
Maevsky, E. 221
Marie, P. 237
Meguro, M. 169
Mitolöhner, R. 205
Nagayama, M. 169
Nakagawa, A. 1
Nui, A. 169
Popel, A.S. 176
Sakai, H. 1, 135
Schäling, S. 205
Simoni, J. 75
Sou, K. 1, 135
Takaori, M. 267
Takeoka, S. 1, 135
Teramura, Y. 1
Tsai, A.G. 70
Tsoukias, N.M. 176
Tsuchida, E. 1, 135, 193
Tsuneshige, A. 186
Tyssebotn, I.M. 217
Watanabe, M. 1
Winslow, R.M. 38
Yonetani, T. 186
Zapol, W.M. 34
Opening Remarks

Professor Yuichiro Anzai
President, Keio University
Chairman, Keio University Medical Science Fund

Distinguished guests, ladies and gentlemen: On behalf of Keio University, it is a great pleasure to welcome all of you to the 13th Keio University International Symposium for Life Sciences and Medicine. I am particularly grateful to the distinguished medical scientists who have traveled such long distances to participate in this meeting.

The major subject of this year’s symposium is “Research and Development of Artificial Oxygen Carrier: Its Front Line.” As various advances have been made in the field of artificial oxygen carrier, I believe that it is an opportune time to hold a symposium at Keio University related to the subject. All speakers kindly accepted our invitation to contribute to this symposium, and I feel certain that this unique meeting will prove both exciting and successful.

Keio was founded in 1858 by Yukichi Fukuzawa and is the oldest university in the country. Fukuzawa was a pioneer in the modernization of Japan. He was a member of the very first mission of the Tokugawa Shogunate government to the United States in 1860 and to European countries in 1862. Before that time, Japan’s doors to the outside world had been closed in a period of self-isolationism lasting almost 300 years. Fukuzawa realized during his visit to the United States and Europe that education and learning were crucially important and inevitable in the future of Japan. Keio has its origins in international exchanges; indeed, international exchanges such as this symposium have been one of the most important academic and social missions of Keio University since its foundation.

In the fall of 1994, Dr. Mitsunada Sakaguchi, an alumnus of the class of 1940 of our medical school, donated five billion yen, approximately 45 million dollars, to the university. He expressed the wish that his fund be used to encourage research in life sciences and medicine and to promote worldwide advancements in life sciences. We agreed with his proposal and thus launched the Keio University Medical Science Fund in April 1995.
Symposia for Life Sciences and Medicine have been organized as one of several projects supported by the fund. In 1999, Dr. Sakaguchi made an additional donation of two billion yen. With these funds, Keio University has established a new laboratory in the field of cell differentiation.

It is thus more than a pleasure, indeed it is an honor, for me to be able to meet the distinguished medical researchers and clinicians from world-renowned institutions who kindly gathered here, and to share in frank and valuable exchanges of views. I am also grateful for the efforts made by the organizing committee, chaired by Dr. Koichi Kobayashi, who has devoted himself to ensuring that this symposium is an auspicious and enjoyable event. I do hope that the meeting will prove a truly fruitful and productive one for you all.

Let me close by wishing everyone gathered here further success in your research and clinical work. Thank you very much.