
Genetics and Biotechnology of Bacilli

Edited by

A. T. GANESAN
and
JAMES A. HOCH

Genetics and Biotechnology of Bacilli

Edited by

A. T. GANESAN

Department of Genetics
Stanford University Medical School
Stanford, California

JAMES A. HOCH

Department of Cellular Biology
Research Institute of Scripps Clinic
La Jolla, California

1984



ACADEMIC PRESS, INC.

(Harcourt Brace Jovanovich, Publishers)

Orlando San Diego New York London
Toronto Montreal Sydney Tokyo

COPYRIGHT © 1984, BY ACADEMIC PRESS, INC.
ALL RIGHTS RESERVED.

NO PART OF THIS PUBLICATION MAY BE REPRODUCED OR
TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC
OR MECHANICAL, INCLUDING PHOTOCOPY, RECORDING, OR ANY
INFORMATION STORAGE AND RETRIEVAL SYSTEM, WITHOUT
PERMISSION IN WRITING FROM THE PUBLISHER.

ACADEMIC PRESS, INC.
Orlando, Florida 32887

United Kingdom Edition published by
ACADEMIC PRESS, INC. (LONDON) LTD.
24/28 Oval Road, London NW1 7DX

Library of Congress Cataloging in Publication Data

International Conference on Genetics and Biotechnology
of Bacilli (2nd : 1983 : Stanford University)
Genetics and biotechnology of bacilli.

"Proceedings of the Second International Conference
on Genetics and Biotechnology of Bacilli, held at Stanford
University, Stanford, California, July 6-8, 1983."

Includes index.

1. Bacillus subtilis--Congresses. 2. Bacillus
thuringiensis--Congresses. 3. Bacterial genetics--
Congresses. 4. Biotechnology--Congresses. I. Ganesan,
A. T. II. Hoch, James A. III. Title.

QR82.B3I58 1983 589.9'5 84-45263

ISBN 0-12-274160-9 (alk. paper)

PRINTED IN THE UNITED STATES OF AMERICA

84 85 86 87 9 8 7 6 5 4 3 2 1

**Genetics
and
Biotechnology
of
Bacilli**

Academic Press Rapid Manuscript Reproduction

Proceedings of the Second International Conference
on the Genetics and Biotechnology of Bacilli
Held at Stanford University, Stanford, California
July 6-8, 1983

Contributors

Numbers in parentheses indicate the pages on which the authors' contributions begin.

- Hannah Alexander¹ (223), *Department of Molecular Biology and Microbiology, Schools of Medicine, Veterinary Medicine, and Dental Medicine, Tufts University and Sackler School of Graduate Biomedical Sciences, Boston, Massachusetts 02111*
- Juan-Carlos Alonso (413), *Max-Planck-Institut für Molekulare Genetik, D-1000 Berlin 33, Federal Republic of Germany*
- Hiroyuki Anaguchi (333), *Department of Applied Biochemistry, Hiroshima University, Fukuyama 720, Japan*
- Amil G. Anderson (19), *Department of Microbiology and Immunology, University of North Carolina School of Medicine, Chapel Hill, North Carolina 27514*
- Linda Anderson (413), *Department of Microbiology, University of North Carolina, Chapel Hill, North Carolina 27514*
- Tadahiko Ando (413), *Department of Microbiology, Riken Institute, Saitama 351, Japan*
- Maryvonne Arnaud (113), *Institut Pasteur, 75724 Paris Cedex 15, France*
- Arthur I. Aronson (359), *Department of Biological Sciences, Purdue University, West Lafayette, Indiana 47907*
- Elisabeth Aubert (113), *Institut Pasteur, 75724 Paris Cedex 15, France*
- Hitoshi Ayaki (333), *Department of Applied Biochemistry, Hiroshima University, Fukuyama 720, Japan*
- R. R. Azizbekyan (345), *Institute of Genetics and Selection of Industrial Microorganisms, VNI Genetica, Moscow 113545, USSR*
- Carl D. B. Banner (163), *Department of Molecular Genetics, Genex Corporation, Gaithersburg, Maryland 20877*
- Marjorie H. Barnes (413), *Department of Pharmacology, University of Massachusetts Medical School, Worcester, Massachusetts 01605*
- William Beckman (359), *Department of Biological Sciences, Purdue University, West Lafayette, Indiana 47907*
- Kenneth F. Bott (19), *Department of Microbiology and Immunology, University of North Carolina School of Medicine, Chapel Hill, North Carolina 27514*

¹Present address: Department of Molecular Biology, Research Institute of Scripps Clinic, La Jolla, California 92037.

- Allan M. Campbell (3), *Department of Biology, Stanford University, Stanford, California 94305*
- Bruce C. Carlton (387), *Department of Molecular and Population Genetics, University of Georgia, Athens, Georgia 30602*
- Glenn H. Chambliss (407), *Department of Bacteriology, University of Wisconsin, Madison, Wisconsin 53706*
- Ellson Y. Chen (173), *Molecular Biology Department, Genentech, Inc., South San Francisco, California 94080*
- G. G. Chestukhina (345), *Institute of Genetics and Selection of Industrial Microorganisms, VNI Genetica, Moscow 113545, USSR*
- V. G. Debabov (345), *Institute of Genetics and Selection of Industrial Microorganisms, VNI Genetica, Moscow 113545, USSR*
- Aline I. Desmyter (235), *Department of Microbiology, Ohio State University, Columbus, Ohio 43210*
- Roy H. Doi (209), *Department of Biochemistry and Biophysics, University of California, Davis, California 95616*
- Eugenie Dubnau (407), *Department of Microbiology, Public Health Research Institute, New York, New York 10016*
- E. J. Duvall (275), *Department of Biological Sciences, University of Maryland, Baltimore County, Catonsville, Maryland 21228*
- Manuel Espinosa² (413), *Department of Biology, Brookhaven National Laboratory, Upton, New York 11973*
- Stanley Falkow (9), *Department of Medical Microbiology, Stanford University Medical School, Stanford, California 94305*
- Eugenio Ferrari (173, 323), *Biocatalysis Department, Genentech, Inc., South San Francisco, California 94080*
- Franco Ferrari (323), *Syntro Corporation, San Diego, California 92121*
- David Filpula (163), *Department of DNA Chemistry, Genex Corporation, Gaithersburg, Maryland 20877*
- Agnès Fouet (113), *Institut Pasteur, 75724 Paris Cedex 15, France*
- Allessandro Galizzi (407), *Department of Genetics and Microbiology, University of Pavia, 27100 Pavia, Italy*
- Philippe Gay (141), *Laboratoire Genetique et Membranes, Institut Jacques Monod, CNRS et Université Paris 7, 75251 Paris Cedex 05, France*
- Michael S. Gilmore (265), *Institut für Genetik und Mikrobiologie, D-8700 Würzburg, Federal Republic of Germany*
- Werner Goebel (265), *Institut für Genetik und Mikrobiologie, D-8700 Würzburg, Federal Republic of Germany*
- David S. Goldfarb³ (209), *Department of Biochemistry and Biophysics, University of California, Davis, California 95616*

²Present address: Instituto de Inmunología y Biología Microbiana, C.S.I.C., Madrid-6, Spain.

³Present address: Department of Structural Biology, Stanford University Medical School, Stanford, California 94305.

- José M. González, Jr. (387), *Department of Molecular and Population Genetics, University of Georgia, Athens, Georgia 30602*
- Christopher J. Green (35), *SRI International, Menlo Park, California 94025*
- Donald M. Green (413), *Department of Biochemistry, University of New Hampshire, Durham, New Hampshire 03824*
- M. Ya. Haykinson (297), *Institute of Genetics and Selection of Industrial Microorganisms, VNIIGenetika, Moscow 113545, USSR*
- A. P. Healey⁴ (67), *Department of Biochemistry, University of Sydney, New South Wales 2006, Australia*
- Dennis J. Henner (173, 249), *Molecular Biology Department, Genentech, Inc., South San Francisco, California 94080*
- Hirohiko Hirochika (333), *Institute for Plant Virus Research, Tsukuba Science City, Ibaraki 305, Japan*
- Hideo Hirokawa (403), *Life Sciences Institute, Sophia University, Tokyo 102, Japan*
- James A. Hoch (323), *Department of Cellular Biology, BCR2, Research Institute of Scripps Clinic, La Jolla, California 92037*
- Philippe Hoet (403), *University of Louvain, 1200 Brussels, Belgium*
- T. P. Iismaa (67), *Department of Biochemistry, University of Sydney, New South Wales 2006, Australia*
- Charles Johnson (407), *The Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138*
- L. Kääriäinen (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- N. Kalkkinen (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- Muriel Kauffmann (309), *Transgene S.A., 67000 Strasbourg, France*
- Fujio Kawamura⁵ (333), *Institute of Applied Microbiology, University of Tokyo, Tokyo 113, Japan*
- André Klier (113), *Institut Pasteur, 75724 Paris Cedex 15, France*
- Yasuo Kobayashi (333), *Department of Applied Biochemistry, Hiroshima University, Fukuyama 720, Japan*
- Ronald Korn⁶ (79), *Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, Colorado 80309*
- Jürgen Kreft (265), *Institut für Genetik und Mikrobiologie, D-8700 Würzburg, Federal Republic of Germany*
- J. W. Kronstad (375), *Department of Microbiology and Immunology, SC-42, University of Washington, Seattle, Washington 98195*

⁴Present address: Queensland Institute of Medical Research, Brisbane 4006, Australia.

⁵Present address: Department of Biochemistry and Biophysics, University of California, Davis, California 95616.

⁶Present address: Albert Einstein College of Medicine, Bronx, New York 10461.

- J. Oliver Lampen (129), *Waksman Institute of Microbiology, Rutgers-The State University of New Jersey, Piscataway, New Jersey 08854*
- Jose M. Lazaro (195), *Centro de Biología Molecular (CSIC-UAM), Universidad Autónoma, Canto Blanco, Madrid-34, Spain*
- Jean-Pierre Lecocq (309), *Transgene S.A., 67000 Strasbourg, France*
- Dominique Le Coq (113, 141), *Institut Jacques Monod, 75251 Paris Cedex 05, France*
- Stuart F. J. LeGrice⁷ (223), *Department of Molecular Biology and Microbiology, Schools of Medicine, Veterinary Medicine and Dental Medicine, Tufts University and Sackler School of Graduate Biomedical Sciences, Boston, Massachusetts 02111*
- P. Lehtovaara⁸ (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- P. S. Lovett (275), *Department of Biological Sciences, University of Maryland, Baltimore County, Catonsville, Maryland 21228*
- K. Lundström⁹ (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- Robert Marrero (403), *Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, Colorado 80309*
- Timothy McKenzie (79), *Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, Colorado 80309*
- Rafael P. Mellado (195), *Centro de Biología Molecular (CSIC-UAM), Universidad Autónoma, Canto Blanco, Madrid-34, Spain*
- Peter S. F. Mézes (129), *Waksman Institute of Microbiology, Rutgers-The State University of New Jersey, Piscataway, New Jersey 08854.*
- Stephan Miller¹⁰ (223), *Department of Molecular Biology and Microbiology, Schools of Medicine, Veterinary Medicine, and Dental Medicine, Tufts University and Sackler School of Graduate Biomedical Sciences, Boston, Massachusetts 02111*
- Scott A. Minnich (359), *Department of Biological Sciences, Purdue University, West Lafayette, Indiana 47907*
- Sumi Mizumoto (51), *Cancer Research Institute, Kanazawa University, Kanazawa 920, Japan*
- S. Mongkolsuk (275), *Department of Biological Sciences, University of Maryland, Baltimore County, Catonsville, Maryland 21228*
- Shigeki Moriya (51), *Cancer Research Institute, Kanazawa University, Kanazawa 920, Japan*

⁷Present address: Institute for Biology, F. Hoffmann-La Roche & Co., A.G., CH-4002 Basel, Switzerland.

⁸Present address: Biotechnical Laboratory, Recombinant-DNA-Group, SF-02150 Espoo 15, Finland

⁹Present address: Research Laboratories of the Finnish State Alcohol Company ALKO Ltd., SF-00101 Helsinki, Finland.

¹⁰Present address: Department of Microbiology, Harvard School of Public Health, Boston, Massachusetts 02115.

- Bodo Müller (265), *Institut für Genetik und Mikrobiologie, D-8700 Würzburg, Federal Republic of Germany*
- Akira Nakayama (181), *Institute of Biological Sciences, University of Tsukuba, Sakura 305, Japan*
- Masanao Oda (333), *Department of Applied Biochemistry, Hiroshima University, Fukuyama 720, Japan*
- Naotake Ogasawara (51), *Cancer Research Institute, Kanazawa University, Kanazawa 920, Japan*
- Kazutaka Ohmura (181), *Institute of Biological Sciences, University of Tsukuba, Sakura 305, Japan*
- Masaji Okamoto (333), *Department of Applied Biochemistry, Hiroshima University, Fukuyama 720, Japan*
- George Ordal (413), *Department of Biochemistry, University of Illinois, Urbana, Illinois 61801*
- G. R. Ostroff¹¹ (285), *Department of Pharmacology, University of Massachusetts Medical School, Worcester, Massachusetts 01605*
- Kiyotaka Otozai (181), *Institute of Biological Sciences, University of Tsukuba, Sakura 305, Japan*
- I. Palva (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- J. J. Pène (285), *School of Life and Health Sciences, University of Delaware, Newark, Delaware 19716*
- John B. Perkins (103), *Department of Cellular and Developmental Biology, The Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138*
- R. Pettersson (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- Chester W. Price (209, 407), *Department of Biochemistry and Biophysics, University of California, Davis, California 95616*
- P. M. Rabinovich (297), *Institute of Genetics and Selection of Industrial Microorganisms, VNIIGenetika, Moscow 113545, USSR*
- Benny Rådén (403), *Department of Bacteriology, Karolinska Institutet, S-104 01 Stockholm, Sweden*
- Georges Rapoport (113), *Institut Pasteur, 75724 Paris Cedex 15, France*
- Pascal Ratet¹² (141), *Laboratoire Genetique et Membranes, Institut Jacques Monod, CNRS et Université Paris 7, 75251 Paris Cedex 05, France*
- John N. Reeve (235), *Department of Microbiology, Ohio State University, Columbus, Ohio 43210*
- Bernard E. Reilly (403), *Department of Microbiology and Dentistry, University of Minnesota, Minneapolis, Minnesota 55455*

¹¹Present address: Genzyme Corporation, Microbiology Research Center, Boston, Massachusetts 02111.

¹²Present address: Institut de Microbiologie, Université Paris-Sud, 91405 Orsay Cedex, France.

- Hans J. Rhaese (407), *Department of Biology, University of Frankfurt, Frankfurt 6000, Federal Republic of Germany*
- Craig S. Rhodes (163), *Department of Molecular Genetics, Genex Corporation, Gaithersburg, Maryland 20877*
- Jacqueline B. Rice (235), *Department of Microbiology, Ohio State University, Columbus, Ohio 43210*
- Huiga Saito (333), *Institute of Applied Microbiology, University of Tokyo, Tokyo 113, Japan*
- Margarita Salas (195), *Centro de Biología Molecular (CSIC-UAM), Universidad Autónoma. Canto Blanco, Madrid-34, Spain*
- Kathleen Sandman (103), *Department of Cellular and Developmental Biology, The Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138*
- M. Sarvas (153), *National Public Health Institute, 00280 Helsinki 28, Finland*
- H. E. Schnepf (375), *Department of Microbiology and Immunology, SC-42, University of Washington, Seattle, Washington 98195*
- Hidenori Shimotsu¹³ (333), *Institute of Applied Microbiology, University of Tokyo, Tokyo 113, Japan*
- M. Sibakov (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- M. T. Smith (67), *Department of Biochemistry, University of Sydney, New South Wales 2006, Australia*
- Jose M. Sogo¹⁴ (195), *Centro de Biología Molecular (CSIC-UAM), Universidad Autónoma, Canto Blanco, Madrid-34, Spain*
- Abraham L. Sonenshein (223), *Department of Molecular Biology and Microbiology, Schools of Medicine, Veterinary Medicine and Dental Medicine, Tufts University and Sackler School of Graduate Biomedical Sciences, Boston, Massachusetts 02111*
- Denis Speck (309), *Transgene S.A., 67000 Strasbourg, France*
- Jean Spence¹⁵ (323), *Syntro Corporation, San Diego, California 92121*
- Mark L. Stahl (173), *Biocatalysis Department, Genentech, Inc., South San Francisco, California 94080*
- Michel Steinmetz (141), *Laboratoire Genetique et Membranes, Institut Jacques Monod, CNRS et Université Paris 7, 75251 Paris Cedex 05, France*
- A. I. Stepanov (297), *Institute of Genetics and Selection of Industrial Microorganisms, VNII Genetica, Moscow 113545, USSR*
- V. M. Stepanov (345), *Institute of Genetics and Selection of Industrial Microorganisms, VNII Genetica, Moscow 113545, USSR*
- Charles Stewart (403), *Department of Biology, Rice University, Houston, Texas 77001*

¹³Present address: Genentech, Inc., South San Francisco, California 94080.

¹⁴Present address: ETH, Institut für Zellbiologie, Höggerburg, CH-8093 Zürich, Switzerland.

¹⁵Present address: Department of Biology, University of Utah, Salt Lake City, Utah 84112.

- George C. Stewart¹⁶ (19), *Department of Microbiology and Immunology, University of North Carolina School of Medicine, Chapel Hill, North Carolina 27514*
- Noboru Sueoka (79), *Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, Colorado 80309*
- K. Takkinen (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- Gakuzo Tamura (181), *Department of Agricultural Chemistry, University of Tokyo, Tokyo 113, Japan*
- Teruo Tanaka (79), *Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, Colorado 80309*
- Leo D. Thompson (163), *Department of Molecular Genetics, Genex Corporation, Gaithersburg, Maryland 20877*
- Donald J. Tipper (407), *Department of Molecular Genetics and Microbiology, University of Massachusetts, Worcester, Massachusetts 01605*
- Kathleen Trach (323), *Department of Cellular Biology, BCR2, Research Institute of Scripps Clinic, La Jolla, California 92037*
- Thomas Trautner (403), *Max-Planck-Institut für Molekulare Genetik, D-1000 Berlin 33, Federal Republic of Germany*
- I. Ulmanen (153), *Recombinant DNA-Laboratory, University of Helsinki, 00380 Helsinki 38, Finland*
- N. Vasantha (163), *Department of Molecular Genetics, Genex Corporation, Gaithersburg, Maryland 20877*
- Gerard Venema (413), *Department of Genetics, Groningen University, Haren, The Netherlands 9751 NN*
- Michael Vodkin (407), *Pathology Division, U.S. Army Research Institute of Infectious Disease, Fort Detrick, Frederick, Maryland 21701*
- Barbara S. Vold (35), *SRI International, Menlo Park, California 94025*
- Michael A. Von Tersch (407), *Department of Molecular and Population Genetics, University of Georgia, Athens, Georgia 30602*
- R. G. Wake (67), *Department of Biochemistry, University of Sydney, New South Wales 2006, Australia*
- Wu Wang (129), *Waksman Institute of Microbiology, Rutgers-The State University of New Jersey, Piscataway, New Jersey 08854*
- Gerhard Weidinger¹⁷ (265), *Institut für Genetik und Mikrobiologie, D-8700 Würzburg, Federal Republic of Germany*
- A. S. Weiss (67), *Department of Biochemistry, University of Sydney, New South Wales 2006, Australia*
- James A. Wells (173), *Biocatalysis Department, Genentech, Inc., South San Francisco, California 94080*

¹⁶Present address: Department of Microbiology, University of Kansas, Lawrence, Kansas 66045.

¹⁷Present address: Institut für Physiologische Chemie, D-8700 Würzburg, Federal Republic of Germany.

- H. R. Whiteley (375), *Department of Microbiology and Immunology, SC-42, University of Washington, Seattle, Washington 98195*
- D. M. Williams (275), *Department of Biological Sciences, University of Maryland, Baltimore County, Catonsville, Maryland 21228*
- Scott Winston (79), *Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, Colorado 80309*
- H. C. Wong¹⁸ (375), *Department of Microbiology and Immunology, SC-42, University of Washington, Seattle, Washington 98195*
- Sui-Lam Wong (209), *Department of Biochemistry and Biophysics, University of California, Davis, California 95616*
- Hidetoshi Yamada (333), *Department of Applied Biochemistry, Hiroshima University, Fukuyama 720, Japan*
- Kunio Yamane (181), *Institute of Biological Sciences, University of Tsukuba, Sakura 305, Japan*
- Makari Yamasaki (181), *Department of Agricultural Chemistry, University of Tokyo, Tokyo 113, Japan*
- Hisato Yamazaki (181), *Institute of Biological Sciences, University of Tsukuba, Sakura 305, Japan*
- Yue-Qin Yang (129), *Waksman Institute of Microbiology, Rutgers-The State University of New Jersey, Piscataway, New Jersey 08854*
- Daniel G. Yansura (249), *Department of Vaccine Development, Genentech, Inc., South San Francisco, California 94080*
- Ronald Yasbin (413), *Department of Microbiology, University of Rochester, Rochester, New York 14642*
- Yu. V. Yomantas (297), *Institute of Genetics and Selection of Industrial Microorganisms, VNI Genetika, Moscow 113545, USSR*
- Hiroshi Yoshikawa (51), *Cancer Research Institute, Kanazawa University, Kanazawa 920, Japan*
- Michael Young (89), *Department of Botany and Microbiology, University College of Wales, Aberystwyth, Dyfed SY23 3DA, United Kingdom*
- Philip Youngman (103), *Department of Cellular and Developmental Biology, The Biological Laboratories, Harvard University, Cambridge, Massachusetts 02138*
- Mark M. Zukowski¹⁹ (309), *Transgene S.A., 67000 Strasbourg, France*

¹⁸Present address: Cetus Corp., Emeryville, California 94608.

¹⁹Present address: Amgen, 1900 Oak Terrace Lane, Thousand Oaks, California 91320.

Preface

The Second International Conference on the Genetics and Biotechnology of Bacilli was held at Stanford University on July 6–8, 1983. Over 280 scientists representing 17 countries gathered to exchange ideas about advances made in this field since the previous conference in 1981. The conference was made possible by the generous financial support of the Syntro Corporation of San Diego, California, and was sponsored by the Syntro Corporation and the Stanford Medical School.

Dr. Dominick Purpura, Dean of Stanford Medical School, and Dr. Thomas Parmeter, President of the Syntro Corporation, opened the conference with welcoming addresses. These were followed by keynote speeches by Dr. Allan M. Campbell, Professor of Biology at Stanford University, and Dr. Stanley Falkow, Professor of Medical Microbiology at Stanford Medical School. There were six main sessions: biotechnology, chromosomal organization, secretion, transcription, cloning, and synthesis of sporulation associated products. These sessions were chaired by Drs. William Phillips, Frank E. Young, J. O. Lampen, Janice Pero, J. A. Hoch, and A. I. Aronson, respectively. In addition to the main sessions, topics that were covered in detail during the previous conference were included in three focus sessions: general genetics, phages, and spores. These sessions were chaired, respectively, by Drs. R. E. Yasbin, T. A. Trautner, and D. J. Tipper, who also summarized the proceedings in this volume. During the three-day conference, about 30 posters were presented.

The contributions to this volume reflect the impressive sophistication that has been achieved in various facets of Bacillus biology, especially in identification of promoters, cloning of foreign genes, and selection of expressed gene products. It is clear from the proceedings that the Bacilli will become the most useful organisms for biotechnological applications.

The articles in this volume were organized and prepared for publication by Ms. Marsha Shearer. Ms. JoAnn Katheiser helped with various aspects of the conference organization at Stanford.

Contents

<i>Contributors</i>	<i>xi</i>
<i>Preface</i>	<i>xix</i>

Opening Session

Opening Address: The Integrated Prophage: Implications and Perspectives	3
<i>Allan M. Campbell</i>	
Opening Remarks: Scatology and Biotechnology	9
<i>Stanley Falkow</i>	

Session I: Chromosomal Organization

Genetic Mapping of Cloned Ribosomal RNA Genes	19
<i>Kenneth F. Bott, George C. Stewart, and Amil G. Anderson</i>	
Transfer RNA Gene Organization in <i>Bacillus subtilis</i>	35
<i>Barbara S. Vold and Christopher J. Green</i>	
Structure and Function of the Region of the Replication Origin of the <i>Bacillus subtilis</i> Chromosome	51
<i>Naotake Ogasawara, Shigeki Moriya, Sumi Mizumoto, and Hiroshi Yoshikawa</i>	
Mapping and Cloning DNA from the Replication Terminus Region of the <i>Bacillus subtilis</i> Chromosome and the Manner of Replication Fork Approach at Termination	67
<i>R. G. Wake, A. S. Weiss, T. P. Iismaa, M. T. Smith, and A. P. Healey</i>	

Two Types of Binding of pUB110 to <i>Bacillus subtilis</i> Membrane	79
<i>Noboru Sueoka, Ronald Korn, Timothy McKenzie, Teruo Tanaka, and Scott Winston</i>	
Gene Amplification in <i>Bacillus subtilis</i> : The Establishment of Multiple Tandemly-Repeated Copies of a Heterologous DNA Segment in the Bacterial Chromosome	89
<i>Michael Young</i>	
New Genetic Methods, Molecular Cloning Strategies, and Gene Fusion Techniques for <i>Bacillus subtilis</i> Which Take Advantage of Tn917 Insertional Mutagenesis	103
<i>Philip Youngman, John B. Perkins, and Kathleen Sandman</i>	
The Sucrose System as a Model of Genetic Regulation in <i>Bacillus subtilis</i>	113
<i>Agnès Fouet, Elisabeth Aubert, Maryvonne Arnaud, André Klier, Georges Rapoport, and Dominique Le Coq</i>	

Session II: Secretion

β -Lactamases of Bacilli: Nature and Processing	129
<i>J. Oliver Lampen, Wu Wang, Peter S. F. Mézes, and Yue-Qin Yang</i>	
A Genetic Approach to Levansucrase Secretion in <i>Bacillus subtilis</i>	141
<i>Dominique Le Coq, Pascal Ratet, Michel Steinmetz, and Philippe Gay</i>	
Secretion of Foreign Gene Products by the Aid of a <i>Bacillus</i> Secretion Vector	153
<i>M. Sibakov, P. Lehtovaara, R. Pettersson, K. Lundström, N. Kalkkinen, I. Ulmanen, K. Takkinen, L. Kääriäinen, I. Palva, and M. Sarvas</i>	
Cloning of a Serine Protease Gene from <i>Bacillus amyloliquefaciens</i> and Its Expression in <i>Bacillus subtilis</i>	163
<i>N. Vasantha, Craig S. Rhodes, Leo D. Thompson, Carl D. B. Banner, and David Filpula</i>	
Cloning and Sequencing of a Region Controlling Efficient Expression of Subtilisin from <i>Bacillus amyloliquefaciens</i>	173
<i>James A. Wells, Eugenio Ferrari, Mark L. Stahl, Dennis J. Henner, and Ellson Y. Chen</i>	

Secretion Vector of <i>Bacillus subtilis</i> Constructed from the <i>Bacillus subtilis</i> α -Amylase Promoter and Signal Peptide Coding Region	181
<i>Kunio Yamane, Kiyotaka Otozai, Kazutaka Ohmura, Akira Nakayama, Hisato Yamazaki, Makari Yamasaki, and Gakuzo Tamura</i>	

Session III: Transcription

<i>In Vitro</i> Transcription of Bacteriophage 029 DNA	195
<i>Margarita Salas, Rafael P. Mellado, Jose M. Lazaro, and Jose M. Sogo</i>	
Structure, Regulation, and Genetic Locus of a Temporally Expressed Promoter of <i>Bacillus subtilis</i>	209
<i>Sui-Lam Wong, Davis S. Goldfarb, Chester W. Price, and Roy H. Doi</i>	
Inhibition by Lipiarmycin of <i>Bacillus subtilis</i> RNA Polymerase	223
<i>Stuart F. J. LeGrice, Hannah Alexander, Stephan Miller, and Abraham L. Sonenshein</i>	
Cloning using Bacteriophage SPPIv as the Vector: Vector Development, Stability, and Expression	235
<i>Aline I. Desmyter, Jacqueline B. Rice, and John N. Reeve</i>	

Session IV: Cloning

Development of an Inducible Promoter for Controlled Gene Expression in <i>Bacillus subtilis</i>	249
<i>Daniel G. Yansura and Dennis J. Henner</i>	
Cloning and Characterization of the Gene for a Thiol-Activated Cytolysin in <i>Bacillus subtilis</i>	265
<i>Jürgen Kreft, Michael S. Gilmore, Bodo Müller, Gerhard Weidinger, and Werner Goebel</i>	
Chloramphenicol Inducibility of Foreign Gene Expression in <i>Bacillus subtilis</i>	275
<i>P. S. Lovett, D. M. Williams, E. J. Duvall, and S. Mongkolsuk</i>	