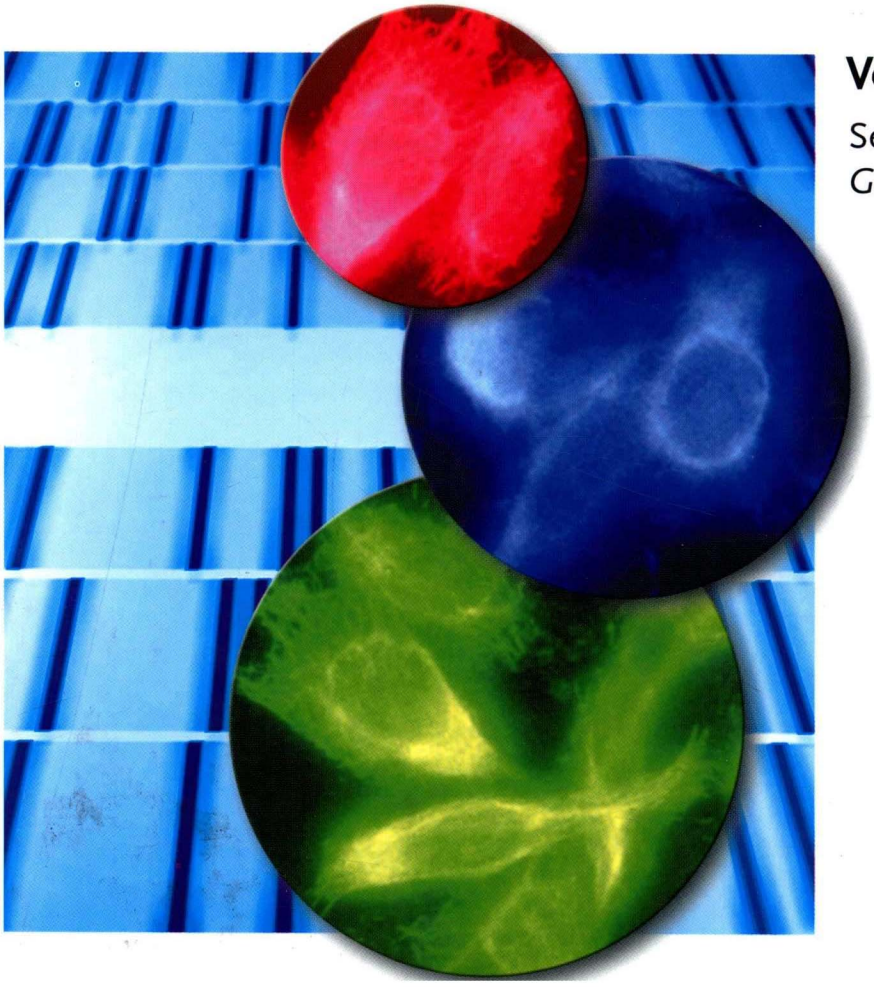
WILEY-VCH

Encyclopedia of Molecular Cell Biology and Molecular Medicine

Edited by Robert A. Meyers



Volume 6

Second Edition

Grow-Info

Encyclopedia of Molecular Cell Biology and Molecular Medicine

Edited by Robert A. Meyers

Second Edition

Volume 6
Growth Factors and Oncogenes in Gastrointestinal Cancers to Informatics (Computational Biology)

WILEY-VCH Verlag GmbH & Co. KGaA

Editor:

Dr. Robert A. Meyers
President, Ramtech Limited
7 Harbor Point Drive, 7A
Mill Valley, CA 94941
USA

Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data: A catalogue record for this book is available from the British Library.

Bibliographic information published by Die Deutsche Bibliothek
Die Deutsche Bibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data is available in the internet at http://dnb.ddb.de.

Printed in the Federal Republic of Germany.
Printed on acid-free paper.

Composition: Laserwords Private Ltd, Chennai, India
Printing: Druckhaus Darmstadt GmbH, Darmstadt
Bookbinding: Litges & Dopf Buchbinderei GmbH, Heppenheim
ISBN-13: 978-3-527-30548-3
ISBN-10: 3-527-30548-3

Encyclopedia of Molecular Cell Biology and Molecular Medicine

Edited by Robert A. Meyers

Volume 6
Growth Factors and Oncogenes in Gastrointestinal Cancers to Informatics (Computational Biology)

Encyclopedia of Molecular Cell Biology and Molecular Medicine

Editorial Board

Preface

The *Encyclopedia of Molecular Cell Biology and Molecular Medicine*, which is the successor and second edition of the *Encyclopedia of Molecular Biology and Molecular Medicine* (VCH Publishers, Weinheim), covers the molecular and cellular basis of life at a university and professional researcher level. The first edition, published in 1996–97, was very successful and is being used in libraries around the world. This second edition will almost double the first edition in length and will comprise the most detailed treatment of both molecular cell biology and molecular medicine available today. The Board Members and I believe that there is a serious need for this publication, even in view of the vast amount of information available on the World Wide Web and in text books and monographs. We feel that there is no substitute for our tightly organized and integrated approach to selection of articles and authors and implementation of peer review standards for providing an authoritative single-source reference for undergraduate and graduate students, faculty, librarians, and researchers in industry and government.

Our purpose is to provide a comprehensive foundation for the expanding number of molecular biologists, cell biologists, pharmacologists, biophysicists, biotechnologists, biochemists, and physicians, as well as for those entering molecular cell biology and molecular medicine from majors or careers in physics, chemistry, mathematics, computer science, and engineering. For example, there is an unprecedented demand for physicists, chemists, and computer scientists who will work with biologists to define the genome, proteome, and interactome through experimental and computational biology.

The Board Members and I first divided the entire study of molecular cell biology and molecular medicine into primary topical categories and further defined each of these into subtopics. The following is a summary of the topics and subtopics:

- *Nucleic Acids:* amplification, disease genetics overview, DNA structure, evolution, general genetics, nucleic acid processes, oligonucleotides, RNA structure, RNA replication and transcription.
- *Structure Determination Technologies Applicable to Biomolecules:* chromatography, labeling, large structures, mapping, mass spectrometry, microscopy, magnetic resonance, sequencing, spectroscopy, X-ray diffraction.
- *Biochemistry:* carbohydrates, chirality, energetics, enzymes, biochemical genetics, inorganics, lipids, mechanisms, metabolism, neurology, vitamins.

Encyclopedia of Molecular Cell Biology and Molecular Medicine, 2nd Edition. Volume 6
Edited by Robert A. Meyers.

ISBN: 3-527-30548-3

- *Proteins, Peptides, and Amino Acids:* analysis, enzymes, folding, mechanisms, modeling, peptides, structural genomics (proteomics), structure, types.
- *Biomolecular Interactions:* cell properties, charge transfer, immunology, recognition, senses.
- *Cell Biology:* developmental cell biology, diseases, dynamics, fertilization, immunology, organelles and structures, senses, structural biology, techniques.
- *Molecular Cell Biology of Specific Organisms:* algae, amoeba, birds, fish, insects, mammals, microbes, nematodes, parasites, plants, viruses, yeasts.
- *Molecular Cell Biology of Specific Organs or Systems:* excretory, lymphatic, muscular, nervous, reproductive, skin.
- *Molecular Cell Biology of Specific Diseases:* cancer, circulatory, endocrinal, environmental stress, immune, infectious, neurological, radiational.
- *Pharmacology:* chemistry, disease therapy, gene therapy, general molecular medicine, synthesis, toxicology.
- *Biotechnology:* applications, diagnostics, gene-altered animals, bacteria and fungi, laboratory techniques, legal, materials, process engineering, nanotechnology, production of classes or specific molecules, sensors, vaccine production.

We then selected some 400 article titles and author or author teams to cover the above topics. Each article is designed as a self-contained treatment which begins with a keyword section including definitions, to assist the scientist or student who is unfamiliar with the specific subject area. The Encyclopedia includes more than 3000 key words, each defined within the context of the particular scientific field covered by the article. In addition to these definitions, the glossary of basic terms found at the back of each volume, defines the most commonly used terms in molecular cell biology. These definitions, along with the reference materials (the genetic code, the common amino acids, and the structures of the deoxyribonucleotides) printed at the back of each volume, should allow most readers to understand articles in the Encyclopedia without referring to a dictionary, textbook, or other reference work. There is, of course, a detailed subject index in Volume 16 as well as a cumulative table of contents and list of authors, as well as a list of scientists who assisted in the development of this Encyclopedia.

Each article begins with a concise definition of the subject and its importance, followed by the body of the article and extensive references for further reading. The references are divided into secondary references (books and review articles) and primary research papers. Each subject is presented on a first-principle basis, including detailed figures, tables and drawings. Because of the self-contained nature of each article, some articles on related topics overlap. Extensive cross-referencing is provided to help the reader expand his or her range of inquiry.

The articles contained in the Encyclopedia include core articles, which summarize broad areas, directing the reader to satellite articles that present additional detail and depth for each subject. The core article Brain Development is a typical example. This 45-page article spans neural induction, early patterning, differentiation, and wiring at a molecular through to cellular and tissue level. It is directly supported, and cross-referenced, by a number of molecular neurobiology satellite articles, for example, Behavior Genes, and further supported by other core presentations, for example,

Developmental Cell Biology; Genetics, Molecular Basis of, and their satellite articles. Another example is the core article on Genetic Variation and Molecular Evolution by Werner Arber. It is supported by a number of satellite articles supporting the evolutionary relatedness of genetic information, for example, Genetic Analysis of Populations.

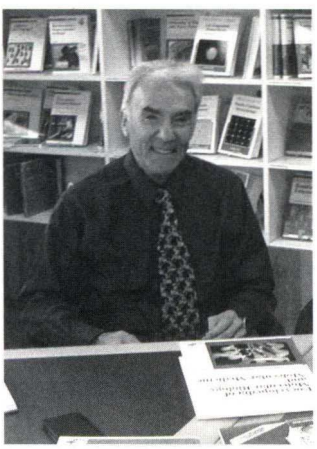
Approximately 250 article titles from the first edition are retained, but rewritten, half by new authors and half by returning authors. Approximately 80 articles on cell biology and 70 molecular biology articles have been added covering areas that have become prominent since preparation of the first edition. Thus, we have compiled a totally updated single source treatment of the molecular and cellular basis of life.

Finally, I wish to thank the following Wiley-VCH staff for their outstanding support of this project: Andreas Sendtko, who provided project and personnel supervision from the earliest phases, and Prisca-Maryla Henheik and Renate Dötzer, who served as the managing editors.

November 2003

Robert A. Meyers
Editor-in-Chief

Editor-in-Chief



Robert A. Meyers

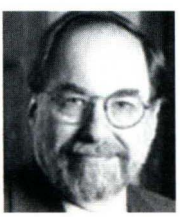
Dr. Meyers earned his Ph.D. in organic chemistry from the University of California Los Angeles, was a post-doctoral fellow at California Institute of Technology and manager of chemical processes for TRW Inc. He has published in *Science*, written or edited 12 scientific books and his research has been reviewed in the *New York Times* and the *Wall Street Journal*. He is one of the most prolific science editors in the world having originated, organized and served as Editor-in-Chief of three editions of the *Encyclopedia of Physical Science and Technology*, the *Encyclopedia of Analytical Chemistry* and two editions of the present *Encyclopedia of Molecular Cell Biology and Molecular Medicine*.

Encyclopedia of Molecular Cell Biology and Molecular Medicine, 2nd Edition. Volume 6
Edited by Robert A. Meyers.

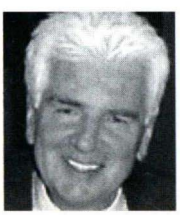
ISBN: 3-527-30548-3

Editorial Board

Werner Arber
Biozentrum, University of Basel, Switzerland
Nobel Prize in Physiology/Medicine for the discovery of restriction enzymes and their application to problems of molecular genetics



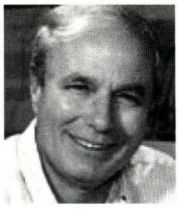
David Baltimore
California Institute of Technology, Pasadena, USA
Nobel Prize in Physiology/Medicine for the discoveries concerning the interaction between tumor viruses and the genetic material of the cell



Günter Blobel
The Rockefeller University, New York, USA
Nobel Prize in Physiology/Medicine for the discovery that proteins have intrinsic signals that govern their transport and localization in the cell

Martin Evans
Cardiff University, United Kingdom
Lasker Award for the development of a powerful technology for manipulating the mouse genome, which allows the creation of animal models of human disease

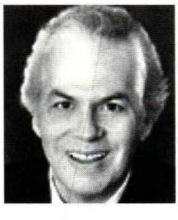
Paul Greengard
The Rockefeller University, New York, USA
Nobel Prize in Physiology/Medicine for the discoveries concerning signal transduction in the nervous system



Avram Hershko
Technion – Israel Institute of Technology, Haifa, Israel
Nobel Prize in Chemistry for the discovery of ubiquitin-mediated protein degration

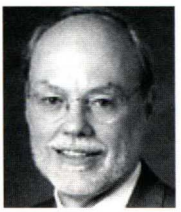
Robert Huber
Max Planck Institute of Biochemistry, Martinsried, Germany
Nobel Prize in Chemistry for the determination of the three-dimensional structure of a photosynthetic reaction centre

Aaron Klug
MRC Laboratory of Molecular Biology Cambridge, United Kingdom
Nobel Prize in Chemistry for the development of crystallographic electron microscopy and his structural elucidation of biologically important nucleic acid-protein complexes



Stanley B. Prusiner
University of California, San Francisco, USA
Nobel Prize in Physiology/Medicine for the discovery of Prions – a new biological principle of infection

Bengt Samuelsson
Karolinska Institute, Stockholm, Sweden
Nobel Prize in Physiology/Medicine for the discoveries concerning prostaglandins and related biologically active substances

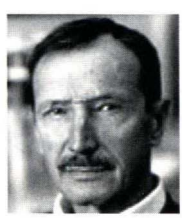


Phillip A. Sharp
Massachusetts Institute of Technology, Cambridge, USA
Nobel Prize in Physiology/Medicine for the discoveries of split genes

Alexander Varshavsky
California Institute of Technology, Pasadena, USA
Lasker Award for the discovery and the recognition of the significance of the ubiquitin system of regulated protein degradation

Akiyoshi Wada
RIKEN Yokohama Institute, Japan
Director of the RIKEN Genomic Science Center

Shigeyuki Yokoyama
RIKEN Yokohama Institute, Japan
Head of the RIKEN Structural Genomics Initiative



Rolf M. Zinkernagel
University Hospital Zurich, Switzerland
Nobel Prize in Physiology/Medicine for the discoveries concerning the specificity of the cell mediated immune defence

List of Contributors

Marie-Isabel Aguilar
Monash University,
Clayton,
Australia

Gino Amiconi
University La Sapienza,
Rome,
Italy

Martin F. Bachmann
Cytos Biotechnology AG,
Zürich-Schlieren,
Switzerland

Edward D. Ball
University of California,
San Diego,
La Jolla, CA,
USA

Barry D. Bavister
University of New Orleans,
New Orleans, LA,
USA

and

Tulane Institute for Reproductive Medicine,
Center for Excellence in Women's Health,
Tulane University Health Sciences Center,
New Orleans, LA,
USA

Carol A. Brenner
University of New Orleans,
New Orleans, LA,
USA

and

Tulane Institute for Reproductive Medicine,
Center for Excellence in Women's Health,
Tulane University Health Sciences Center,
New Orleans, LA,
USA

Maurizio Brunori
University La Sapienza,
Rome,
Italy

Richard Bucala
Yale University School of Medicine,
New Haven, CT,
USA

Ralph A. Bungard
University of Canterbury,
Christchurch,
New Zealand

Thomas R. Bürglin
Department of Biosciences at Novum and CGB,
Karolinska Institutet,
Huddinge,
Sweden

Encyclopedia of Molecular Cell Biology and Molecular Medicine, 2nd Edition. Volume 6
Edited by Robert A. Meyers.

ISBN: 3-527-30548-3

Charles R. Cantor
Sequenom, Inc.,
San Diego, CA,
USA

and

Boston University,
Boston, MA,
USA

Max A. Chernesky
Department of Pathology and
Molecular Medicine,
Hamilton, ON,
Canada

Raveendra Dayam
University of Southern California,
Los Angeles, CA,
USA

Thomas Ebensen
GBF-German Research Centre for
Biotechnology,
Braunschweig,
Germany

Sarah C. R. Elgin
Washington University,
St. Louis, MO,
USA

Francesco Giannelli
Department of Medical and
Molecular Genetics,
Division of Genetics and Development,
Guy's, King's and St. Thomas'
School of Medicine,
London,
UK

James P. Gosling
Department of Biochemistry,
National University of Ireland,
Galway,
Ireland

Peter M. Green
Department of Medical and
Molecular Genetics,
Division of Genetics and Development,
Guy's, King's and St. Thomas'
School of Medicine,
London,
UK

Carlos A. Guzmán
GBF-German Research Centre for
Biotechnology,
Braunschweig,
Germany

Jack A. Heinemann
University of Canterbury,
Christchurch,
New Zealand

Peter R. Holman
University of California,
San Diego,
La Jolla, CA,
USA

Lynn B. Jorde
University of Utah Health Sciences Center,
Salt Lake City, Utah,
USA

Hans Michael Kubisch
Tulane National Primate Research Center,
Covington, LA,
USA

Thomas M. Kundig
University of Zürich,
Zürich,
Switzerland

Tzong-Hsien Lee
Monash University,
Clayton,
Australia

Boris A. Leibovitch
Washington University,
St. Louis, MO,
USA

Thomas Lengauer
Computational Biology and Applied Algorithmics,
Max-Planck-Institute for Informatics,
Saarbrücken,
Germany

Avital Lev
Technion-Israel Institute of Technology,
Haifa,
Israel

Claudia Link
GBF-German Research Centre for Biotechnology,
Braunschweig,
Germany

Ron L. Marshall
Molecular Diagnostics,
Abbott Park, IL,
USA

Christine N. Metz
North Shore-Long Island Jewish Research Institute,
Manhasset, NY,
USA

Jeremy E. Moss
Yale University School of Medicine,
New Haven, CT,
USA

Nouri Neamati
University of Southern California,
Los Angeles, CA,
USA

Eric G. Pamer
Sloan-Kettering Institute,
New York,
USA

Astrid K. Petrich
Department of Pathology and Molecular Medicine,
Hamilton, ON,
Canada

Alexander Ploss
Sloan-Kettering Institute,
New York,
USA

and

Weill Graduate School of Medical Sciences of Cornell University,
New York,
USA

Thomas L. Poulos
University of California,
Irvine, CA,
USA

Yoram Reiter
Technion-Israel Institute of Technology,
Haifa,
Israel

Takeshi Sano
Beth Israel Deaconess Medical Center,
Harvard Medical School,
Boston, MA,
USA

Eiichi Tahara
Hiroshima University,
Hiroshima,
Japan

Cindy Takeuchi
The Scripps Research Institute,
La Jolla, CA,
USA

Paul Wentworth
The Scripps Research Institute,
La Jolla, CA,
USA

and

University of Oxford,
Oxford,
UK

Color Plates

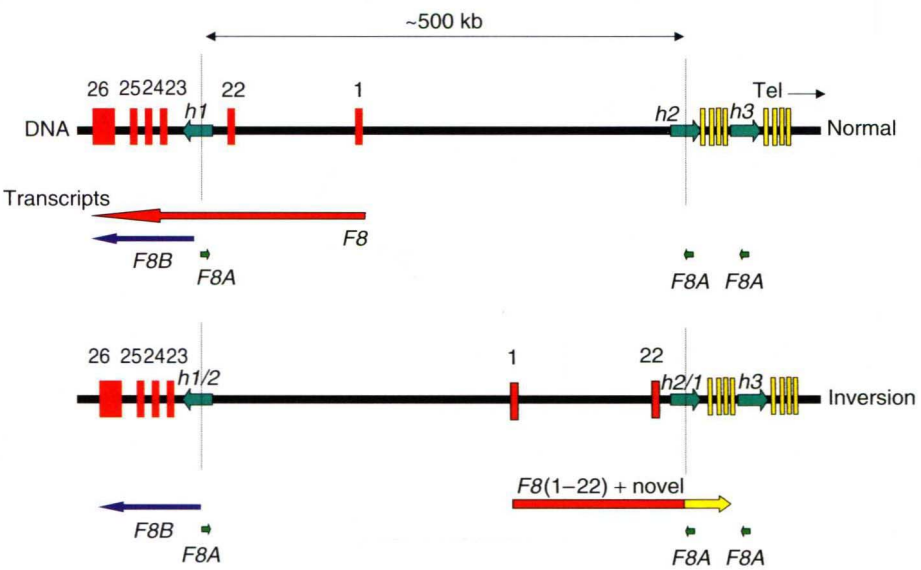


Fig. 5 (p. 118) Diagram of *int22h*-related inversion, showing its transcriptional consequences. Top: normal structure of DNA region and *F8* gene transcripts (not drawn to scale). *F8* = transcript encoding coagulant factor, *F8A* and *F8B* = transcripts arising from CpG island in *int22h* repeat. Green arrows in genomic DNA represent *int22h* repeats (*h*1 = *int22h*-1, *h*2 = *int22h*-2, *h* = *int22h*-3). Red bars indicate some numbered exons of the *F8* gene, yellow bars are exons unrelated to the *F8* gene. Vertical dotted lines are sites where intranemic homologous recombination occurs and leads to the inversion. Tel → shows direction to telomere. Arrow point in transcripts indicates 3′ end. Bottom: structure of DNA region with inversion resulting from recombination of *int22h*-1 with *int22h*-2. *H1/2* and *h2/1* are the recombined *int22h* repeats. The transcripts show that the *F8* transcript contains only exons 1 to 22 of *F8* attached to the normally unrelated yellow exons and that exons 23 to 26 are present only in the *F8B* transcript. NB inversions involving *int22h*-3 yield analogous transcripts.

Encyclopedia of Molecular Cell Biology and Molecular Medicine, 2nd Edition. Volume 6
Edited by Robert A. Meyers.

ISBN: 3-527-30548-3