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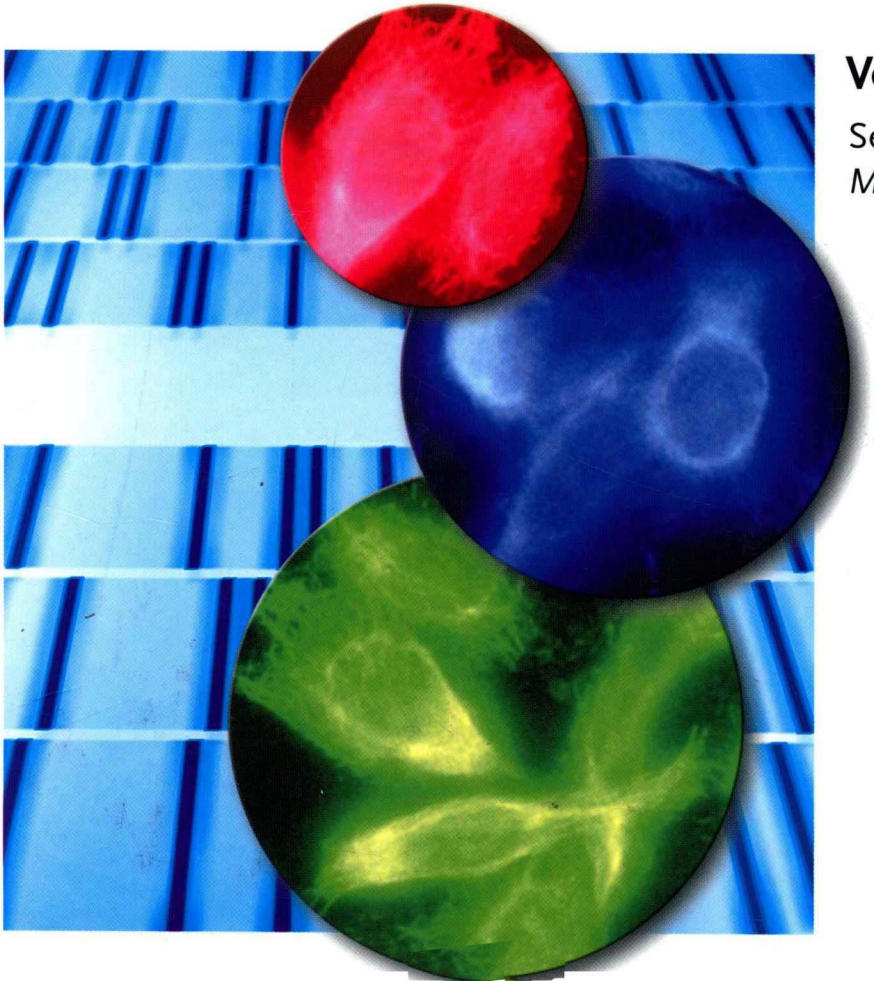
Encyclopedia of Molecular Cell Biology and Molecular Medicine

Edited by Robert A. Meyers



Volume 9

Second Edition

Muta-Orga

Encyclopedia of Molecular Cell Biology and Molecular Medicine

Edited by Robert A. Meyers

Second Edition

Volume 9

Mutagenesis, Malignancy and Genome Instability to Organic Cofactors as Coenzymes

WILEY-VCH Verlag GmbH & Co. KGaA

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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: 978-3-527-30551-3
ISBN-10: 3-527-30551-3

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Encyclopedia of Molecular Cell Biology and Molecular Medicine

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 9
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ISBN: 3-527-30551-3

- *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.

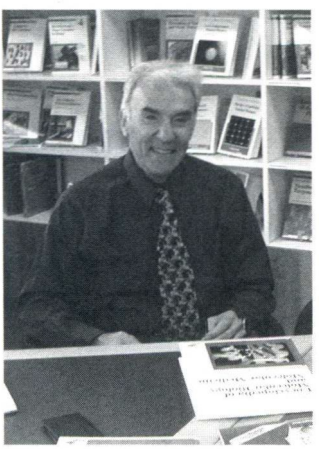
Approximately 250 article titles from the first edition are retained, but rewritten, half by new authors and half by returning authors. Approximately 80 articles on cell biology and 70 molecular biology articles have been added covering areas that have become prominent since preparation of the first 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*.

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Editorial Board

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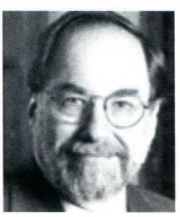
Nobel Prize in Physiology/Medicine for the discovery of restriction enzymes and their application to problems of molecular genetics



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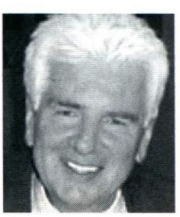
California Institute of Technology, Pasadena, USA
Nobel Prize in Physiology/Medicine for the discoveries concerning the interaction between tumor viruses and the genetic material of the cell



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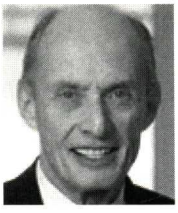
Nobel Prize in Physiology/Medicine for the discovery that proteins have intrinsic signals that govern their transport and localization in the cell

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



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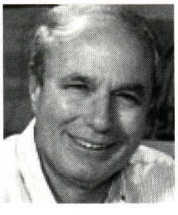

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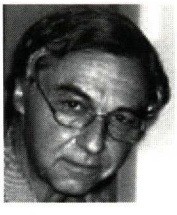
Technion – Israel Institute of Technology, Haifa, Israel
Nobel Prize in Chemistry for the discovery of ubiquitin-mediated protein degration



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
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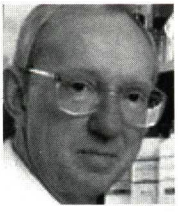
Nobel Prize in Chemistry for the development of crystallographic electron microscopy and his structural elucidation of biologically important nucleic acid-protein complexes

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
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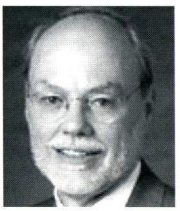
Nobel Prize in Physiology/Medicine for the discoveries concerning prostaglandins and related biologically active substances



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Nobel Prize in Physiology/Medicine for the discoveries of split genes

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Lasker Award for the discovery and the recognition of the significance of the ubiquitin system of regulated protein degradation

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Edited by Robert A. Meyers.

ISBN: 3-527-30551-3

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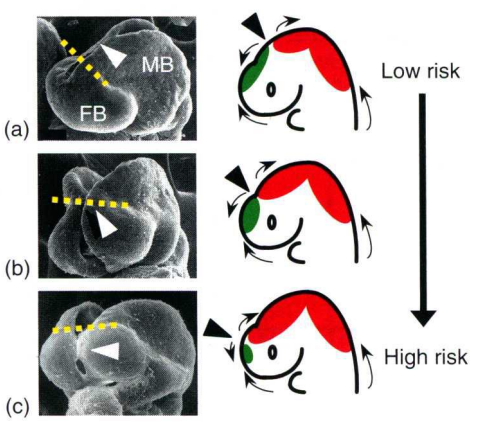

Fig. 3 (p. 127) Variations in position of Closure 2, in the future brain of different inbred mouse strains, in relation to the risk of exencephaly and anencephaly. Left panel shows scanning electron micrographs of embryonic brains from the left frontal view. Dotted lines indicate the forebrain/midbrain (FB/MB) boundary. Arrowheads point to the site of initiation of Closure, which is located caudal to the FB/MB boundary in the DBA/2 strain (a), at the FB/MB boundary in the CD1 strain (b), and rostral to the FB/MB boundary in the NZW strain (c). Middle panel summarizes diagrammatically this variation in Closure 2 morphology. Red shading indicates open neural folds caudal to the site of Closure 2, whereas green shading indicates the anterior neuropore, rostral to Closure 2. Arrows indicate direction of neural tube closure. Right panel shows an increasing risk of exencephaly correlated with a progressively more rostral position of Closure 2. The reason for this correlation is that the midbrain region, which lies at the apex of the cranial flexure, is mechanically the least favorable brain region for neural tube closure, and is aided in its closure by a caudal Closure 2 position (a) but hampered in its closure by a rostral Closure 2 position (c). Modified from Fleming, A., Copp, A.J. (2000) *Hum. Mol. Genet.* **9**, 575–581.

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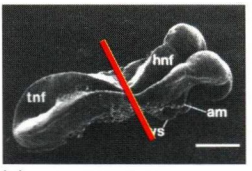
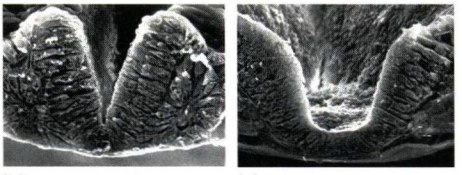


(a)



(b) +/+ (c) *Lp/Lp*

Fig. 5 (p. 129) Initiation of neurulation (Closure 1) in the mouse embryo, as studied by scanning electron microscopy. (a) Whole E8.5 embryo demonstrating the approaching neural folds approximately half way along the body axis, indicating the incipient Closure 1 event. This event occurs at the boundary of the hindbrain and cervical regions. (b, c) Sections transverse to the body axis as indicated by the red line in (a). The wild type embryo (b) shows "Mode 1" morphology with bending at a compact midline hinge point, and straight lateral neural folds. The homozygous *loop-tail* (*Lp/Lp*) embryo (c) shows a disturbance of the midline, which is broader than normal, without a compact bend in the neural plate. Although the neural folds elevate, laterally, they are not able to appose and fuse in the midline, leading to craniorachischisis in mutant embryos. Scale bar represents 0.25 mm (a) and 0.03 mm (b, c). Modified from Copp, A.J., Brook, F.A., Estibeiro, J.P., Shum, A.S.W., Cockroft, D.L. (1990) *Prog. Neurobiol.* **35**, 363–403; Greene, N.D.E., Gerrelli, D., Van Straaten, H.W.M., Copp, A.J. (1998) *Mech. Dev.* **73**, 59–72.

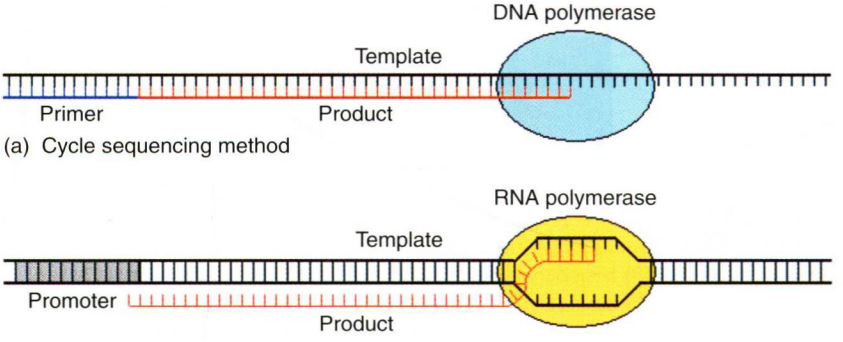


Fig. 1 (p. 398) Schematic comparison of TS and cycle sequencing methods. (a) Cycle sequencing method. Black line indicates template (ssDNA). Blue line indicates primer, which is elongated by DNAP to give the reaction product (red line). Elongation of product terminates either spontaneously or when DNAP incorporates a terminator (2′, 3′-deoxyribonucleotide triphosphate). (b) TS method. Black line indicates template (dsDNA). Gray zone indicates promoter region, which is the starting point of the transcript (red line). Elongation of product terminates either spontaneously or when RNAP incorporates a terminator (3′-deoxyribonucleic triphosphate).