COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY

VOLUME LXXIII

<http://symposium.cshlp.org>

Institutions that have purchased the hardcover edition of this book are entitled to online access to the Symposium website. Please contact your institution's library to gain access to the website. The site contains the full-text articles from the 2008 Symposium and previous Symposia from 2004 onward.

If you received this book from Cold Spring Harbor Laboratory Press directly, the packing slip included with this book contains your activation instructions. If you received this book from your agent, please have your agent contact us for your activation instructions.

If you do not have an account number or are experiencing access problems, please contact Kathy Cirone, CSHL Press Subscription Manager, at 1-800-843-4388, extension 4044 (Continental U.S. and Canada), 516-422-4100 (all other locations), cironek@cshl.edu, or sqb-feedback@highwire.stanford.edu.

COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY

VOLUME LXXIII

Control and Regulation of Stem Cells

<http://symposium.cshlp.org>

Meeting Organized by Bruce Stillman, David Stewart, and Terri Grodzicker
COLD SPRING HARBOR LABORATORY PRESS
2008

COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY VOLUME LXXIII

©2008 by Cold Spring Harbor Laboratory Press
International Standard Book Number 978-0-87969-861-4 (cloth)
International Standard Book Number 978-0-87969-862-1 (paper)
International Standard Serial Number 0091-7451
Web International Standard Serial Number 1943-4456
Library of Congress Catalog Card Number 34-8174

Printed in the United States of America

All rights reserved

COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY

Founded in 1933 by

REGINALD G. HARRIS

Director of the Biological Laboratory 1924 to 1936

Previous Symposia Volumes

I (1933) Surface Phenomena	XXXVII (1972) The Mechanism of Muscle Contraction
II (1934) Aspects of Growth	XXXVIII (1973) Chromosome Structure and Function
III (1935) Photochemical Reactions	XXXIX (1974) Tumor Viruses
IV (1936) Excitation Phenomena	XL (1975) The Synapse
V (1937) Internal Secretions	XLI (1976) Origins of Lymphocyte Diversity
VI (1938) Protein Chemistry	XLII (1977) Chromatin
VII (1939) Biological Oxidations	XLIII (1978) DNA: Replication and Recombination
VIII (1940) Permeability and the Nature of Cell Membranes	XLIV (1979) Viral Oncogenes
IX (1941) Genes and Chromosomes: Structure and Organization	XLV (1980) Movable Genetic Elements
X (1942) The Relation of Hormones to Development	XLVI (1981) Organization of the Cytoplasm
XI (1946) Heredity and Variation in Microorganisms	XLVII (1982) Structures of DNA
XII (1947) Nucleic Acids and Nucleoproteins	XLVIII (1983) Molecular Neurobiology
XIII (1948) Biological Applications of Tracer Elements	XLIX (1984) Recombination at the DNA Level
XIV (1949) Amino Acids and Proteins	L (1985) Molecular Biology of Development
XV (1950) Origin and Evolution of Man	LI (1986) Molecular Biology of <i>Homo sapiens</i>
XVI (1951) Genes and Mutations	LII (1987) Evolution of Catalytic Function
XVII (1952) The Neuron	LIII (1988) Molecular Biology of Signal Transduction
XVIII (1953) Viruses	LIV (1989) Immunological Recognition
XIX (1954) The Mammalian Fetus: Physiological Aspects of Development	LV (1990) The Brain
XX (1955) Population Genetics: The Nature and Causes of Genetic Variability in Population	LVI (1991) The Cell Cycle
XXI (1956) Genetic Mechanisms: Structure and Function	LVII (1992) The Cell Surface
XXII (1957) Population Studies: Animal Ecology and Demography	LVIII (1993) DNA and Chromosomes
XXIII (1958) Exchange of Genetic Material: Mechanism and Consequences	LIX (1994) The Molecular Genetics of Cancer
XXIV (1959) Genetics and Twentieth Century Darwinism	LX (1995) Protein Kinesis: The Dynamics of Protein Trafficking and Stability
XXV (1960) Biological Clocks	LXI (1996) Function & Dysfunction in the Nervous System
XXVI (1961) Cellular Regulatory Mechanisms	LXII (1997) Pattern Formation during Development
XXVII (1962) Basic Mechanisms in Animal Virus Biology	LXIII (1998) Mechanisms of Transcription
XXVIII (1963) Synthesis and Structure of Macromolecules	LXIV (1999) Signaling and Gene Expression in the Immune System
XXIX (1964) Human Genetics	LXV (2000) Biological Responses to DNA Damage
XXX (1965) Sensory Receptors	LXVI (2001) The Ribosome
XXXI (1966) The Genetic Code	LXVII (2002) The Cardiovascular System
XXXII (1967) Antibodies	LXVIII (2003) The Genome of <i>Homo sapiens</i>
XXXIII (1968) Replication of DNA in Microorganisms	LXIX (2004) Epigenetics
XXXIV (1969) The Mechanism of Protein Synthesis	LXX (2005) Molecular Approaches to Controlling Cancer
XXXV (1970) Transcription of Genetic Material	LXXI (2006) Regulatory RNAs
XXXVI (1971) Structure and Function of Proteins at the Three-dimensional Level	LXXII (2007) Clocks and Rhythms

Front Cover (Paperback): Human stem cells differentiating to neurons. Staining for β -tubulin and DAPI. Courtesy of Juan Carlos Izpisua Belmonte at the Center for Regenerative Medicine, Barcelona. **Back Cover (Paperback):** A brain lobe from a *Drosophila* third-instar larva labeled with Dlg (red), BrdU (green), and DAPI (blue). The large red cells are the neural stem cells of the central brain. (Courtesy of Jakob von Trotha and Andrea H. Brand.)

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by Cold Spring Harbor Laboratory Press, provided that the appropriate fee is paid directly to the Copyright Clearance Center (CCC). Write or call CCC at 222 Rosewood Drive, Danvers, MA 01923 (508-750-8400) for information about fees and regulations. Prior to photocopying items for educational classroom use, contact CCC at the above address. Additional information on CCC can be obtained at CCC Online at <http://www.copyright.com/>

All Cold Spring Harbor Laboratory Press publications may be ordered directly from Cold Spring Harbor Laboratory Press, 500 Sunnyside Boulevard, Woodbury, NY 11797-2924. Phone: 1-800-843-4388 in Continental U.S. and Canada. All other locations: (516) 422-4100. FAX: (516) 422-4097. E-mail: cshpress@cshl.edu. For a complete catalog of all Cold Spring Harbor Laboratory Press publications, visit our World Wide Web site <http://www.cshlpress.com/>

Website Access: Institutions that have purchased the hardcover edition of this book are entitled to online access to the companion website at <http://symposium.cshlp.org>. For assistance with activation, please contact Kathy Cirone, CSHL Press Subscription Manager, at cironek@cshl.edu.

Symposium Participants

- ABRANCHES, ELSA, Dept. of Developmental Biology, Institute of Molecular Medicine, Lisbon, Portugal
- ADAMS, JERRY, Div. of Molecular Genetics of Cancer, The Walter and Eliza Hall Institute of Medical Research, Melbourne, Australia
- ADOLPHE, CHRISTELLE, Swiss Institute for Cancer Research, Ecole Polytechnique Fédéral de Lausanne, Epalinges, Switzerland
- AIGNER, STEFAN, Lab. of Genetics, Biterials, Seoul, La Jolla, California
- AKALA, OMOBOLAJI, Institute for Stem Cell Biology and Regenerative Medicine, School of Medicine, Stanford University, Stanford, California
- ALCANTARA LLAGUNO, SHEILA, Dept. of Developmental Biology, Southwestern Medical Center, University of Texas, Dallas
- ALFRED, JANE, *Development*, Company of Biologists, Cambridge, United Kingdom
- AL-HAJJ, MUHAMMAD, Dept. of Cancer Biology, AstraZeneca, Gaithersburg, Maryland
- ALVAREZ-BUYLLA, ARTURO, Dept. of Neurological Surgery, Program in Developmental and Stem Cell Biology, University of California, San Francisco
- AMARIGLIO, NINETTE, Cancer Research Center, Sheba Medical Center, Tel Hashomer, Israel
- ANDERS, DAVID, New York State Dept. of Health, New York State Stem Cell Science, Wadsworth Center, Albany, New York
- ANDROUTSELLIS-THEOTOKIS, ANDREAS, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- ARANDA, VICTORIA, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- AUSONI, SIMONETTA, Dept. of Biomedical Sciences, University of Padua, Padua, Italy
- BAGCHI, ANINDYA, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- BAI, LIXIA, Dept. of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington
- BAKER, MONYA, *Nature Reports Stem Cells*, Nature Publishing Group, San Francisco, California
- BALASUBRAMANIAN, D., Kallam Anji Reddy Campus, L.V. Prasad Eye Institute, Hyderabad, India
- BALINT, BALINT, Dept. of Biochemistry and Molecular Biology, University of Debrecen, Debrecen, Hungary
- BANK, ARTHUR, Dept. of Genetics and Development, Columbia University, New York, New York
- BARON, MARGARET, Dept. of Medicine, Black Family Stem Cell Institute, Mt. Sinai School of Medicine, New York, New York
- BEAUSÉJOUR, CHRISTIAN, Dept. of Pharmacology, CHU Ste-Justine, Université de Montréal, Montréal, Québec, Canada
- BERNARDOS, REBECCA, Dept. of Neurobiology, Medical School, University of Massachusetts, Worcester
- BERTA, MELANIE, Lab. of Epithelial Cell Biology, Cancer Research UK, Cambridge, United Kingdom
- BEYRET, ERGIN, Dept. of Cell Biology, Stem Cell Center, Yale University, New Haven, Connecticut
- BHATTACHARYA, PARAMITA, Lab. of Metabolism, National Cancer Institute, National Institutes of Health, Bethesda, Maryland
- BLIN, GUILLAUME, Dept. of Cardiomyopathy, Institut National de la Santé et de la Recherche Médicale, Université d'Evry, Evry, France
- BOGESTAL, YALDA, Dept. of Biomedicine, Gothenburg University, Gothenburg, Sweden
- BORGHESI, LISA, Dept. of Immunology, School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania
- BOTELHO, JOAO, Champalimaud Foundation, Lisbon, Portugal
- BRAND, ANDREA, Dept. of Physiology, Development, and Neuroscience, Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- BROWNE, CATHERINE, Institute of Molecular Bioscience, University of Queensland, Brisbane, Australia
- BUAC, KRISTINA, Genetics Disease Research Branch, National Human Genome Institute, National Institutes of Health, Bethesda, Maryland
- BUCKINGHAM, MARGARET, Dept. of Developmental Biology, Centre National de la Recherche Scientifique, Pasteur Institute, Paris, France
- BUSHELL, WILLIAM, Dept. of Anthropology, Massachusetts Institute of Technology, Cambridge, Massachusetts
- CALS-GRIERSON, MARIE-MADELEINE, Dept. of Life Sciences, L'Oreal Research, Clichy, France
- CARBONNEAU, CYNTHIA, Dept. of Pharmacology, Centre de Recherche, CHU Ste-Justine, Université de Montréal, Montréal, Québec, Canada
- CAROTTA, SEBASTIAN, Div. of Immunology, The Walter and Eliza Hall Institute of Medical Research, Melbourne, Australia
- CARROLL, PATRICK, Dept. of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington
- CELLOT, SONIA, Dept. of Medicine, Institute for Research in Immunology and Cancer, University of Montréal, Montréal, Québec, Canada
- CESARI, FRANCESCA, *Nature Reviews Molecular Cell Biology*, Nature Publishing Group, London, United Kingdom
- CHAI, HYUN JONG, Biterials, Seoul, Korea
- CHALAMALASETTY, RAVINDRA B., Lab. of Cancer and Developmental Biology, National Cancer Institute, Frederick, Maryland
- CHANG, DAVID, Dept. of Bone Marrow Transplant, Div. of Research Immunology, Children's Hospital Los Angeles, Los Angeles, California

- CHATTERJEE, SAMIT, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- CHEN, CHUN-MING, Dept. of Life Sciences, National Yang-Ming University, Taipei, Taiwan
- CHEN, JIAN, Dept. of Developmental Biology, Southwestern Medical Center, University of Texas, Dallas
- CHEN, JUN AN, Dept. of Pathology, Columbia University, New York, New York
- CHEN, LEI, Dept. of Pathology, Stanford University, Stanford, California
- CHEN, MUHAN, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- CHEN, THERESA, Dept. of Medicine, VA Palo Alto Health Care System, Palo Alto, California
- CHEN, TING, Lab. of Mammalian Cell Biology and Development, Howard Hughes Medical Institute, The Rockefeller University, New York, New York
- CHEN, XI, Dept. of Biological Sciences, National University of Singapore, Singapore
- CHENG, LI-CHUN, Dept. of Pathology, Columbia University, New York, New York
- CHEN-KIANG, SELINA, Dept. of Pathology, Weill-Cornell Medical College, New York, New York
- CHENOWETH, JOSHUA, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- CHI, HUNG YUAN, Lab. of Mammalian Cell Biology and Development, Howard Hughes Medical Institute, The Rockefeller University, New York, New York
- CHIEN, KENNETH, Cardiovascular Research Center, Massachusetts General Hospital, Boston, Massachusetts
- CHILDERS, MARTIN, Dept. of Neurology, School of Medicine, Wake Forest University, Winston-Salem, North Carolina
- CHIN, BENNETT, Dept. of Radiology, Duke University, Durham, North Carolina
- CHOI, JINHYANG, Dept. of Biomedical Sciences, Cornell University, Ithaca, New York
- CHOI, KYUNG-DAL, Dept. of Pathology, Lab. of Medicine, University of Wisconsin, Madison
- CHOU, RUEY-HWANG, Center for Molecular Medicine, Medical University of China, Tai-Chung, Taiwan
- CHRISTOPHERSEN, NICOLAJ, Centre for Epigenetics, University of Copenhagen, Copenhagen, Denmark
- CHUANG, AARON T.T., Dept. of Neurodegeneration Research, GlaxoSmithKline, Harlow, United Kingdom
- CIMADAMORE, FLAVIO, Stem Cells and Regeneration Program, Burnham Institute for Medical Research, La Jolla, California
- CLEVERS, HANS, Dept. of Immunology and Molecular Genetics, Hubrecht Institute for Developmental Biology, Utrecht, The Netherlands
- CONNELL, LAUREEN, *Genes & Development*, Cold Spring Harbor Laboratory Press, Woodbury, New York
- CORMIER, CATHERINE, Institute of Proteomics, Harvard Medical School, Cambridge, Massachusetts
- CORONAS, VALÉRIE, Institut de Physiologie et Biologie Cellulaires, Centre National de la Recherche Scientifique, University of Poitiers, Poitiers, France
- COTTRELL, TRICIA, Div. of Rheumatology, School of Medicine, Johns Hopkins University, Baltimore, Maryland
- CRAWFORD, SARAH, Dept. of Biology, Southern Connecticut State University, New Haven
- CROSIER, PHILIP, Dept. of Molecular Medicine, School of Medicine, University of Auckland, Auckland, New Zealand
- CURTIS, STEPHEN, Dept. of Genetics, Stem Cell Program, Children's Hospital, Harvard Medical School, Boston, Massachusetts
- DALERBA, PIERO, Institute for Stem Cell Biology and Regenerative Medicine, Stanford University, Stanford, California
- DALEY, GEORGE, Div. of Hematology and Oncology, Children's Hospital, Boston, Massachusetts
- DAMELIN, MARC, Dept. of Oncology, Wyeth Research, Pearl River, New York
- DANIELSON, LAURA, Dept. of Pathology, New York University School of Medicine, New York, New York
- DAVIES, ERIN, Dept. of Developmental Biology, Stanford University, Stanford, California
- DAVIS, MATHEW, Dept. of Research, OncoMed Pharmaceuticals, Redwood City, California
- DECATHELINEAU, AIMEE, *Journal of Cell Biology*, The Rockefeller University Press, New York, New York
- DE JONG, PIETER, BACPAC Resources, Children's Hospital and Research Center Oakland, Oakland, California
- DENG, YIBIN, Dept. of Cancer Genetics, M.D. Anderson Cancer Center, University of Texas, Houston
- DENLI, AHMET, Lab. of Genetics, The Salk Institute for Biological Studies, La Jolla, California
- DEPINHO, RONALD, Dept. of Medical Oncology, Dana-Farber Cancer Institute, Boston, Massachusetts
- DE SOUZA, NATALIE, *Nature Methods*, Nature Publishing Group, New York, New York
- DOETSCH, FIONA, Dept. of Pathology, Neurology, and Neuroscience, Columbia University, New York, New York
- DONOVAN, SHANE, Dept. of BioScience, Baxter Healthcare, Round Lake, Illinois
- DOSS, MICHAEL, Dept. of Medicine, Weill Cornell Medical College, New York, New York
- DOULATOV, SERGEI, Dept. of Molecular and Medical Genetics, University of Toronto, Toronto, Ontario, Canada
- DU, MIN, Dept. of Animal Science, University of Wyoming, Laramie
- DUBOWITZ, VICTOR, Institute of Child Health, University College, University of London, London, United Kingdom
- DUPIN, ELISABETH, Institute of Neurobiology, Centre National de la Recherche Scientifique, Gif-sur-Yvette, France
- EBERT, JOAN, Cold Spring Harbor Laboratory Press, Woodbury, New York
- ECONOMIDES, ARIS, Dept. of Genome Engineering and Technology Development, Regeneron Pharmaceuticals, Tarrytown, New York
- EDOFF, KARIN, Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- EGGER, BORIS, Dept. of Physiology, Development, and Neuroscience, Wellcome Trust Cancer Research, U.K. Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- EISENBERGER, TOBIAS, Developmental Biology Unit, European Molecular Biology Laboratory, Heidelberg, Germany
- ENCINAS, JUAN MANUEL, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York

SYMPOSIUM PARTICIPANTS

vii

- ENGLE, SANDRA, GeMM CoE Database, Pfizer, Groton, Connecticut
- ENIKOLOPOV, GRIGORI, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- EPPERT, KOLJA, Div. of Cell and Molecular Biology, University Health Network, Toronto, Ontario, Canada
- EPSTEIN, DAVID, Dept. of Oncology Research, OSI Pharmaceuticals, Farmingdale, New York
- ERIKSSON, MALIN, Dept. of Cell and Molecular Biology, Karolinska Institute, Stockholm, Sweden
- EYLER, CHRISTINE, Dept. of Pharmacology and Cancer Biology, Duke University, Durham, North Carolina
- FALKOWSKA-HANSEN, BERIT, Div. of Genetics of Skin Carcinogenesis, German Cancer Research Center, Heidelberg, Germany
- FAZZIO, THOMAS, Hooper Foundation, University of California, San Francisco
- FERREIRA, MIGUEL, Gulbenkian Institute of Science, Lisbon, Portugal
- FLEMING, WILLIAM, Dept. of Hematology, Oncology, and Medicine, Oregon Health and Sciences University, Portland, Oregon
- FRANZ, WOLFGANG, Medical Clinic, University of Munich-Grosshadern, Munich, Germany
- FRIAS, ANA, University of Minho, Braga, Portugal
- FUCHS, ELAINE, Lab. of Mammalian Cell Biology and Development, Howard Hughes Medical Institute, The Rockefeller University, New York, New York
- FUENTE MORA, CRISTINA, School of Biological Sciences, University of Liverpool, Liverpool, United Kingdom
- FULLER, MARGARET, Dept. of Developmental Biology, School of Medicine, Stanford University, Stanford, California
- GAIANO, NICHOLAS, Institute for Cell Engineering, School of Medicine, Johns Hopkins University, Baltimore, Maryland
- GALLIOT, BRIGITTE, Dept. of Zoology and Animal Biology, University of Geneva, Geneva, Switzerland
- GAVRILIUC, OANA, Dept. of Immunology and Physiology, University of Medicine and Pharmacy Victor Babes, Timisoara, Romania
- GAVRILOV, SVETLANA, Dept. of Genetics and Development, Columbia University, New York, New York
- GENANDER, MARIA, Dept. of Cell and Molecular Biology, Karolinska Institute, Stockholm, Sweden
- GIANGRECO, ADAM, Keratinocyte Laboratory, Cancer Research U.K., University of Cambridge, Cambridge, United Kingdom
- GIFFORD, DAVID, Dept. of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts
- GINESTIER, CHRISTOPHE, Dept. of Internal Medicine, Comprehensive Cancer Center, University of Michigan, Ann Arbor
- GLUDISH, DAVID, Dept. of Hematology and Oncology, Children's Hospital, Boston, Massachusetts
- GOLD, KATRINA, Dept. of Physiology, Development, and Neuroscience, Wellcome Trust Cancer Research, U.K. Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- GOTHARD, DAVID, Dept. of Tissue Engineering and Modelling, Wolfson Centre, University of Nottingham, Nottingham, United Kingdom
- GRECO, VALENTINA, Lab. of Mammalian Cell Biology and Development, Howard Hughes Medical Institute, The Rockefeller University, New York, New York
- GREENE, MICHELLE, Scientific Collaborations, Millipore Corporation, West Palm Beach, Florida
- GREENFIELD, RAZI, Dept. of Cellular Biochemistry and Human Genetics, Hebrew University, Jerusalem, Israel
- GREVE, JEFFREY, Dept. of Biopharmaceuticals, Exelixis, South San Francisco, California
- GRODZICKER, TERRI, Cold Spring Harbor Laboratory Press, Woodbury, New York
- GROSSNIKLAUS, UELI, Institute of Plant Biology, University of Zürich, Zürich, Switzerland
- GUIJARRO, MARIA, Dept. of Pathology, New York University Medical Center, New York, New York
- GUO, BING, Dept. of Oncology, Wyeth, Pearl River, New York
- HALEY, JOHN, Translational Research, OSI Pharmaceuticals, Farmingdale, New York
- HAMRA, F. KENT, Dept. of Pharmacology, Southwestern Medical Center, University of Texas, Dallas
- HAN, JONG JIN, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- HANNON, GREGORY, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- HAO, HSIAO-NAN, Dept. of Orthopaedic Surgery, School of Medicine, Wayne State University, Detroit, Michigan
- HARTER, M.L. (NIKKI), Dept. of Biochemistry, Case Western Reserve University, Cleveland, Ohio
- HASHIMOTO, SHUICHI, Dept. of Pulmonary, Allergy, and Critical Care, Duke University Medical Center, Durham, North Carolina
- HASS, MATTHEW, Dept. of Developmental Biology, Washington University, St. Louis, Missouri
- HE, WEI, Dept. of Discovery Oncology, Hoffmann La Roche, Nutley, New Jersey
- HE, YE, Dept. of Neuroscience and Cell Biology, University of Medicine and Dentistry of New Jersey, Robert Wood Johnson Medical School, Piscataway, New Jersey
- HECHT, MERAV, Dept. of Cell Biochemistry and Human Genetics, Hebrew University, Jerusalem, Israel
- HELIN, KRISTIAN, Copenhagen Biocenter, Biotech Research and Innovation Centre, Copenhagen, Denmark
- HENSELEIT, KORINNA, Centre for Cutaneous Research, Queen Mary University, London, United Kingdom
- HERRERA, FRANCISCO, Dept. of Molecular and Cell Biology, University of California, Berkeley
- HO, LENA, Dept. of Immunology, Stanford University, Stanford, California
- HOCHEDLINGER, KONRAD, Center for Regenerative Medicine, Cancer Center, Massachusetts General Hospital, Boston, Massachusetts
- HOEPPNER, DANIEL, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- HOGAN, BRIGID, Dept. of Cell Biology, Duke University Medical Center, Durham, North Carolina
- HOLOWACZ, TAMARA, Canadian Centre for Biomolecular Research, University of Toronto, Toronto, Canada
- HOPE, KRISTIN, Dept. of Medicine, Institute for Research in Cancer and Immunology, Montréal, Canada
- HRECKA, KASIA, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York

- HUA, KATE, Institute of Pharmacology, National Yang Ming University, Taipei, Taiwan
- HUEBNER, MICHAEL, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- HUR, EUN MI, Dept. of Biology, California Institute of Technology, Pasadena, California
- IBARRA, INGRID, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- ICHIMURA, MICHIO, BioFrontier Laboratories, Kyowa Hakko Kogyo, Machidashi, Japan
- INGLIS, JOHN, Cold Spring Harbor Laboratory Press, Woodbury, New York
- IZPISÚA BELMONTE, JUAN CARLOS, Lab. of Gene Expression, The Salk Institute for Biological Studies, La Jolla, California
- JACOB, BINDYA, Div. of Genetics and Genomics, Institute of Molecular and Cell Biology, Singapore
- JAENISCH, RUDOLF, Dept. of Biomedical Research, Whitehead Institute for Biomedical Research, Massachusetts Institute of Technology, Cambridge, Massachusetts
- JAKIMO, ALAN, Dept. of Law, Hofstra University, Hempstead, New York
- JANSSEN, KAAREN, Cold Spring Harbor Laboratory Press, Woodbury, New York
- JENSEN, UFFE, Dept. of Clinical Genetics, Vejle Hospital, Vejle, Denmark
- JIANG, XIN, Dept. of Cardiology, Massachusetts General Hospital, Boston, Massachusetts
- JOHANSSON, HELENA, Dept. of Medical Biochemistry and Cell Biology, University of Gothenburg, Gothenburg, Sweden
- JONES, DEBORAH, Oncology Discovery Technology Group, GlaxoSmithKline, Collegeville, Pennsylvania
- JULIANO, CELINA, Dept. of Molecular Biology, Cell Biology, and Biochemistry, Brown University, Providence, Rhode Island
- JUNG, JIN, Dept. of Physiology, School of Medicine, Pusan National University, Pusan, South Korea
- KADYK, LISA, Dept. of Biopharmaceuticals, Exelixis, South San Francisco, California
- KALABIS, JIRI, Dept. of Gastroenterology, University of Pennsylvania, Philadelphia
- KANG, KYUNG-SUN, Adult Stem Cell Research Center, College of Veterinary Medicine, Seoul National University, Seoul, South Korea
- KANG, SOO, Dept. of Physiology, School of Medicine, Pusan National University, Pusan, South Korea
- KARETA, MICHAEL, Dept. of Molecular and Cellular Biology, University of California, Davis
- KAUSHAL, SHALESH, Dept. of Ophthalmology, University of Florida, Gainesville
- KEHLER, JAMES, Lab. of Molecular Biology, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- KELLER, GORDON, McEwen Centre for Regenerative Medicine, Toronto, Ontario, Canada
- KESHET, GILMOR, Cancer Research Center, Sheba Medical Center, Tel Hashomer, Israel
- KEYES, WILLIAM, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- KIKYO, NOBUAKI, Stem Cell Institute, University of Minnesota, Minneapolis
- KIM, CARLA, Dept. of Genetics, Stem Cell Program, Children's Hospital, Harvard Medical School, Boston, Massachusetts
- KIM, HANA, Dept. of Biological Sciences, Louisiana State University, Baton Rouge
- KIM, JUN SUNG, Dept. of Research, Bionerics, Seoul, South Korea
- KIM, MIN-JU, Dept. of Research and Development, Stemgent, San Diego, California
- KIM, TAE-SHIN, Dept. of Biological Sciences, Korea Advanced Institute of Science and Technology, Daejeon, South Korea
- KINOSHITA, MASAKI, Lab. for Stem Cell Biology, RIKEN Center for Developmental Biology, Kobe, Japan
- KLASEN, CHRISTIAN, Transgenic Service, European Molecular Biology Laboratory, Heidelberg, Germany
- KLOC, ANNA, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- KORKAYA, HASAN, Dept. of Internal Medicine, Comprehensive Cancer Center, University of Michigan, Ann Arbor
- KOST, THOMAS, Molecular Discovery Research, GlaxoSmithKline, Research Triangle Park, North Carolina
- KOTVAL, JERROO, Dept. of Health of New York State, Wadsworth Center, Albany, New York
- KOUADIO, TANO, Dept. of Cellular Biology and Development, Institut de Génétique et de Biologie Moléculaire et Cellulaire, Illkirch, France
- KOULAKOV, ALEX, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- KRISHNAMURTHY, SUDHA, Dept. of Restorative Sciences, School of Dentistry, University of Michigan, Ann Arbor
- KRUIER, WIEBE, Dept. of Molecular Cell Biology, University of Twente, Enschede, The Netherlands
- KUIPERS, HEDWICH, Dept. of Pathology and Neuropathology, VU University Medical Center, Amsterdam, The Netherlands
- KUMARAN, ILENG, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- KUO, CHAY, Dept. of Cell Biology, Duke University Medical Center, Durham, North Carolina
- LAN, FEI, Constellation Pharmaceuticals, Cambridge, Massachusetts
- LANDRY, YANNICK, Dept. of Pharmacology, CHU Ste-Justine Research Center, Université de Montréal, Montréal, Québec, Canada
- LARSEN, ELISABETH, Dept. of Molecular Biology, Massachusetts General Hospital, Boston, Massachusetts
- LAWSON, DEVON, Dept. of Microbiology, Immunology, and Molecular Genetics, University of California, Los Angeles
- LAWTON, LEE, Whitehead Institute for Biomedical Research, Cambridge, Massachusetts
- LAZETIC, SASHA, Dept. of Molecular Cell Biology, OncoMed Pharmaceuticals, Redwood City, California
- LECHMAN, ERIC, Dept. of Cell and Molecular Biology, University Health Network, Toronto, Ontario, Canada
- LEE, CHANG GEUN, Dept. of Molecular and Cellular Biology, School of Medicine, Sungkyunkwan University, Suwon, South Korea
- LEE, JOO-HYEON, Dept. of Biological Sciences, Korea Advanced Institute of Science and Technology, Daejeon, South Korea
- LEE, YOONSUNG, Dept. of Cell Biology, Duke University Medical Center, Durham, North Carolina

SYMPOSIUM PARTICIPANTS

ix

- LEE, YOUNG, Dept. of Regenerative Medicine, Maria Biotech, Seoul, South Korea
- LEHMANN, RUTH, Skirball Institute, New York University School of Medicine, New York, New York
- LEMISCHKA, IHOR, Dept. of Gene and Cell Medicine, Mount Sinai School of Medicine, New York, New York
- LI, BINGBING, Dept. of Biology, Indiana University-Purdue University, Indianapolis, Indiana
- LI, CHUNG, Institute of Cellular and Organismic Biology, Genomics Research Center, Academia Sinica, Taipei, Taiwan
- LI, LIQI, Lab. of Mammalian Genes and Development, National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Maryland
- LI, XIN, Dept. of Molecular Biology and Genetics, Cornell University, Ithaca, New York
- LI, YINA, Dept. of Cell and Developmental Biology, School of Medicine, Vanderbilt University, Nashville, Tennessee
- LI, ZHIZHONG, Dept. of Pharmacology and Cancer Biology, Duke University, Durham, North Carolina
- LIANG, CHIH-CHIA, Dept. of Life Sciences, National Yang-Ming University, Taipei, Taiwan
- LIAO, JUN, Dept. of Molecular, Cellular, and Developmental Biology, Yale University, New Haven, Connecticut
- LIM, DAE-SIK, Dept. of Biological Science, Korea Advanced Institute for Science and Technology, Daejeon, South Korea
- LIN, HAIFAN, Dept. of Cell Biology and Genetics, Stem Cell Center, Yale University, New Haven, Connecticut
- LIU, CHUNG HSIEN, Plastic Surgery and Stem Cell Therapy Center, American Academy of Cosmetic Surgery, Chia-Yi City, Taiwan
- LIU, XIAOFEI, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- LIU, YAN, Dept. of Medicine, Memorial Sloan-Kettering Cancer Center, New York, New York
- LIU, YANG, Dept. of Research and Development, Stemgent, San Diego, California
- LORENZO, LAUREANNE, Dept. of Molecular Microbiology and Immunology, University of Maryland, Baltimore
- LOWE, SCOTT, Howard Hughes Medical Institute, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- LU, BAISONG, Institute for Regenerative Medicine, Wake Forest University, Winston-Salem, North Carolina
- LU, WANGE, Dept. of Biochemistry and Molecular Biology, University of Southern California, Los Angeles, California
- LUKACS, RITA, Dept. of Microbiology, Immunology, and Molecular Genetics, University of California, Los Angeles
- LUPO, GIUSEPPE, Dept. of Physiology, Development, and Neuroscience, University of Cambridge, Cambridge, United Kingdom
- MACFARLAN, TODD, Lab. of Gene Expression, The Salk Institute for Biological Studies, La Jolla, California
- MACK, DAVID, Mammary Biology and Tumorigenesis Laboratory, National Cancer Institute, National Institutes of Health, Bethesda, Maryland
- MAEDGE, BRITTA, *Cell*, Cell Press, Cambridge, Massachusetts
- MAENG, SUNGHO, Dept. of Regenerative Medicine, Maria Biotech, Seoul, South Korea
- MAERKI, DAVID, Dept. of Anatomy, University of Zürich, Zürich, Switzerland
- MAHERALI, NIMET, Center for Regenerative Medicine, Cancer Center, Massachusetts General Hospital, Boston, Massachusetts
- MAHONY, SHAUN, Dept. of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts
- MAJUMDER, SADHAN, Dept. of Cancer Genetics, M.D. Anderson Cancer Center, University of Texas, Houston
- MALETIĆ-SAVATIĆ, MIRJANA, Dept. of Neurology, Stony Brook University Medical Center, Stony Brook, New York
- MANTESSO, ANDREA, Dept. of Craniofacial Development, Kings College, London, United Kingdom
- MAROLT, DARJA, Dept. of Biomedical Engineering, Columbia University, New York, New York
- MARSHAK, DANIEL, Corporate Headquarters, Perkin-Elmer, Waltham, Massachusetts
- MARTELLO, GRAZIANO, Dept. of Histology, Microbiology, and Medical Biotechnology, University of Padua, Padova, Italy
- MARTIENSSSEN, ROBERT, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- MATSAS, REBECCA, Lab. of Cellular and Molecular Neurobiology, Hellenic Pasteur Institute, Athens, Greece
- MAZUREK, ANTHONY, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- MAZZONI, ESTEBAN, Dept. of Pathology, Columbia University, New York, New York
- MCDONNELL, KEVIN, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- McKAY, RONALD, Lab. of Molecular Biology, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- McQUALTER, JONATHAN, Adult Lung Stem Cell Laboratory, Australian Stem Cell Centre, Monash University, Clayton, Australia
- MELTON, COLLIN, Dept. of Urology, University of California, San Francisco
- MELTON, DOUGLAS, Dept. of Molecular and Cellular Biology, Howard Hughes Medical Institute, Harvard University, Cambridge, Massachusetts
- MERRILL, BRAD, Dept. of Biochemistry and Molecular Genetics, University of Illinois, Chicago
- MEUWISSEN, RALPH, Institut National de la Santé et de la Recherche Médicale, Institut Albert Bonniot, Grenoble, France
- MEYERROSE, TODD, Dept. of Biomedical Research, Whitehead Institute for Biomedical Research, Cambridge, Massachusetts
- MEYN, STEPHEN, Program in Genetics and Genome Biology, The Hospital for Sick Children, Toronto, Ontario, Canada
- MITTAL, VIVEK, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- MOLYNEUX, GEMMA, Dept. of Mammary Stem Cells, Institute of Cancer Research, London, United Kingdom
- MORONI, MARIA CRISTINA, Dept. of Experimental Oncology, European Institute of Oncology, Milan, Italy
- MORRISON, SEAN, Dept. of Cell and Developmental Biol-

- ogy, University of Michigan, Ann Arbor
- MURATANI, MASAFUMI, Transcription Laboratory, Cancer Research UK, London, United Kingdom
- MURR, RABIH, International Agency for Research on Cancer, Lyon, France
- MURTUZA, BARI, Dept. of Medicine, Imperial College, Northwood, Middlesex, United Kingdom
- NAKANISHI, ATSUSHI, Frontier Research Laboratories, Takeda Pharmaceutical Company, Tsukuba, Ibaraki, Japan
- NAKANO, ATSUSHI, Cardiovascular Research Center, Massachusetts General Hospital, Boston, Massachusetts
- NAPPER, JENNIFER, Dept. of Biochemistry and Microbiology, School of Medicine, Marshall University, Huntington, West Virginia
- NARKIS, GINAT, National Institute for Child Health and Human Development, National Institutes of Health, Bethesda, Maryland
- NAVARRO, PABLO, Dept. of Developmental Biology, Institut Pasteur, Paris, France
- NEMAJEROVA, ALICE, Dept. of Pathology, Stony Brook University, Stony Brook, New York
- NEWMARK, PHILLIP, Dept. of Cell and Developmental Biology, University of Illinois, Urbana-Champaign
- NG, HUCK-HUI, Dept. of Stem Cell Biology, Genome Institute of Singapore, Singapore
- NGUYEN, HOANG, Dept. of Molecular and Cellular Biology, Baylor College of Medicine, Houston, Texas
- NI, HSIAO-TZU, Dept. of Antibody Application, R&D Systems, Minneapolis, Minnesota
- NIKI, MASARU, Dept. of Internal Medicine, University of Iowa, Iowa City
- NIMER, STEVEN, Dept. of Hematology, Memorial Sloan-Kettering Cancer Center, New York, New York
- NISHIKAWA, SHIN-ICHI, Dept. of Stem Cell Biology, RIKEN Center for Developmental Biology, Kobe, Japan
- NOLDE, MONA, Dept. of Cell Biology, Stem Cell Center, Yale University, New Haven, Connecticut
- NOWAK, JONATHAN, Lab. of Mammalian Cell Biology and Development, The Rockefeller University, New York, New York
- NURY, DAVID, ISTEM, Institut National de la Santé et de la Recherche Médicale, Unité Mixte de Recherche, University of Evry, Evry, France
- NUSSE, ROEL, Dept. of Developmental Biology, Howard Hughes Medical Institute, Stanford University, Stanford, California
- O'BRIEN, LUCY ERIN, Dept. of Molecular and Cell Biology, University of California, Berkeley
- ORKIN, STUART, Howard Hughes Medical Institute, Children's Hospital, Harvard Medical School, Boston, Massachusetts
- ORLANDO, VALERIO, Dept. of Epigenetics and Genome Reprogramming, Dulbecco Telethon Institute, Fondazione Telethon, Naples, Italy
- OSENBERG, SIVAN, Dept. of Genetics, Tel Aviv University, Tel Aviv, Israel
- OUGLAND, RUNE, Dept. of Molecular Biology, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts
- OVIEDO, NESTOR, Dept. of Developmental Biology, Center for Regenerative and Developmental Biology, Forsyth Institute, Harvard Medical School, Boston, Massachusetts
- OWUSU-ANSAH, EDWARD, Dept. of Molecular Cell and Developmental Biology, University of California, Los Angeles
- PAIN, BERTRAND, School of Medecine, Institut National de la Santé et de la Recherche Médicale, Unité Mixte de Recherche, Centre National de la Recherche Scientifique, Clermont-Ferrand, France
- PALAKODETI, DASARADHI, Dept. of Genetics and Developmental Biology, Health Science Center, University of Connecticut, Farmington
- PAN, HAIYAN, Dept. of Microbiology, Medical Center, Columbia University, New York, New York
- PAN, YI, Dept. of Immunology, Merck, Rahway, New Jersey
- PANKRATZ, MATTHEW, Lab. of Gene Expression, The Salk Institute for Biological Studies, La Jolla, California
- PARADA, LUIS, Dept. of Developmental Biology, Southwestern Medical Center, University of Texas, Dallas
- PARIENTE, NONIA, *EMBO Reports*, Nature Publishing Group, Heidelberg, Germany
- PARK, ANGIE INKYUNG, Dept. of Cancer Biology, Oncomed Pharmaceuticals, Redwood City, California
- PARK, JUNE-HEE, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- PARK, SAEYOUNG, Dept. of Regenerative Medicine, Maria Biotech, Seoul, South Korea
- PATEL, PARTHIVE, Dept. of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington
- PATEL, SHETAL, Abramson Family Cancer Research Institute, University of Pennsylvania, Philadelphia
- PELICCI, GIULIANA, Dept. of Experimental Oncology, European Institute of Oncology, Milan, Italy
- PERSAUD, TRIKALDARSHI, Dept. of Genome Engineering Technology, Regeneron Pharmaceuticals, Tarrytown, New York
- PERVIN, SHEHLA, Dept. of Obstetrics and Gynecology, University of California, Los Angeles
- PESTELL, RICHARD, Kimmel Cancer Center, Jefferson University, Philadelphia, Pennsylvania
- PING, YUEH-HSIN, Institute of Pharmacology, National Yang-Ming University, Taipei, Taiwan
- POLLOCK, MILA, Cold Spring Harbor Laboratory Library, Cold Spring Harbor, New York
- PREMSRIRUT, PREM, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- PUCÉAT, MICHEL, Institut National de la Santé et de la Recherche Médicale, Unité Mixte de Recherche, University of Evry, Evry, France
- QIAN, DALONG, Institute for Stem Cell Biology and Regenerative Medicine, Stanford University, Stanford, California
- QYANG, YIBING, Medicine, Cardiovascular Research Center, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts
- RAISER, DAVE, Dept. of Genetics, Stem Cell Program, Children's Hospital, Harvard Medical School, Boston, Massachusetts
- RALSTON, AMY, Dept. of Developmental and Stem Cell Biology, Hospital for Sick Children, Toronto, Ontario, Canada
- RAMALHO-SANTOS, MIGUEL, Institute for Regeneration Medicine, University of California, San Francisco

SYMPOSIUM PARTICIPANTS

xi

- RANDO, THOMAS, Dept. of Neurology and Neurological Sciences, School of Medicine, Stanford University, Stanford, California
- RANGAN, PRASHANTH, Dept. of Developmental Genetics, Howard Hughes Medical Institute, School of Medicine, New York University, New York
- RAO, NANDINI, Dept. of Biology, Indiana University-Purdue University, Indianapolis, Indiana
- RAPP, ULF, Institut für Medizinische Strahlenkunde und Zellforschung, University of Würzburg, Würzburg, Germany
- RAVIN, REA, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- REBATCHOUK, DMITRI, Dept. of Biological Sciences, Sanofi-Aventis, Bridgewater, New Jersey
- RECHAVI, GIDEON, Cancer Research Center, Sheba Medical Center, Tel Hashomer, Israel
- REID, LOLA, Institute for Regenerative Medicine, School of Medicine, Wake Forest University, Winston-Salem, North Carolina
- REINER, STEVEN, Dept. of Medicine, Abramson Family Cancer Research Institute, University of Pennsylvania, Philadelphia
- REINKE, VALERIE, Dept. of Genetics, School of Medicine, Yale University, New Haven, Connecticut
- RENDL, MICHAEL, Dept. of Developmental and Regenerative Biology, Mount Sinai School of Medicine, New York, New York
- RICH, JEREMY, Dept. of Medicine, Duke University Medical Center, Durham, North Carolina
- RICUPERO, CHRISTOPHER, Dept. of Cell Biology and Neuroscience, Rutgers University, Piscataway, New Jersey
- RIO, CARLOS, Dept. of Regenerative Medicine, Fundación Caubet, Centro Internacional de Medicina Respiratoria Avanzada, Bunyola, Spain
- ROACH, REBECCA, Dept. of Genetics, Stem Cell Program, Harvard Stem Cell Institute, Children's Hospital, Harvard Medical School, Boston, Massachusetts
- RODRIGUES, CLAUDIA, Dept. of Molecular and Cellular Pharmacology, Leonard M. Miller School of Medicine, University of Miami, Miami, Florida
- ROHRSCHEIDER, LARRY, Dept. of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle, Washington
- ROLLINS, FRED, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- ROSARIO, LUIS, Gulbenkian Institute of Science, Lisbon, Portugal
- ROSSMANN, MARLIES, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- ROTHSTEIN, RODNEY, Dept. of Genetics and Development, Columbia University Medical Center, New York, New York
- ROY, RAHUL, Dept. of Chemistry and Chemical Biology, Harvard University, Cambridge, Massachusetts
- RUARO, MARIA ELISABETTA, Dept. of Neurobiology, International School for Advanced Studies, Trieste, Italy
- RUDNICKI, MICHAEL, Sprott Centre for Stem Cell Research, Ottawa Health Research Institute, Ottawa, Ontario, Canada
- RUDOLPH, K. LEONARD, Institute of Molecular Medicine, Ulm University, Ulm, Germany
- SALVAGIOTTO, GIORGIA, Dept. of Blood Research, WiCell Research Institute, Madison, Wisconsin
- SÁNCHEZ ALVARADO, Alejandro, Dept. of Neurobiology and Anatomy, Howard Hughes Medical Institute, University of Utah, Salt Lake City
- SARMENTO, OLGA, Dept. of Cell Biology, Health Science Center, University of Virginia, Charlottesville
- SAUNDERS, LAURA, Gladstone Institute of Virology and Immunology, University of California, San Francisco
- SAUVAGEAU, GUY, Institute for Research in Immunology and Cancer, University of Montréal, Montréal, Québec, Canada
- SCHERES, BEN, Dept. of Molecular Cell Biology, Utrecht University, Utrecht, The Netherlands
- SCHNAPP, ESTHER, Stem Cell Research Institute, DiBiT, Centro San Raffaele, Milan, Italy
- SCIMONE, MARIA LUCILA, Dept. of Biology, Whitehead Institute for Biomedical Research, Massachusetts Institute of Technology, Cambridge, Massachusetts
- SEITA, JUN, Institute for Stem Cell Biology and Regenerative Medicine, Stanford University, Stanford, California
- SEO, SACHIKO, Dept. of Hematology and Oncology, University of Tokyo, Tokyo, Japan
- SESHI, BEERELLI, Dept. of Pathology, Los Angeles Biomedical Research Institute at Harbor-UCLA, Torrance, California
- SEVER, RICHARD, Cold Spring Harbor Laboratory Press, Woodbury, New York
- SHARMA, MANJU, Dept. of Research, The Jackson Laboratory, Bar Harbor, Maine
- SHARMA, PRANAV, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- SHCHERBATA, HALYNA, Dept. of Biochemistry, University of Washington, Seattle
- SHEN, MICHAEL, Depts. of Medicine and Genetics and Development, Columbia University Medical Center, New York, New York
- SHERR, CHARLES, Dept. of Tumor Cell Biology, Howard Hughes Medical Institute, St. Jude Children's Research Hospital, Memphis, Tennessee
- SHEU, YI-JUN, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- SHINOHARA, TAKASHI, Dept. of Molecular Genetics, Kyoto University, Kyoto, Japan
- SHIRAS, ANJALI, Dept. of Molecular Biology, National Centre for Cell Science, Pune, India
- SIDDALL, NICOLE, Dept. of Anatomy and Cell Biology, University of Melbourne, Parkville, Australia
- SIEGRIST, SARAH, Dept. of Molecular and Cell Biology, University of California, Berkeley
- SIERRA, AMANDA, Dept. of Neurology, Stony Brook University, Stony Brook, New York
- SINGH, SANJAY, Dept. of Cancer Genetics, M.D. Anderson Cancer Center, University of Texas, Houston
- SINKEVICIUS, KERSTIN, Children's Hospital Stem Cell Program, Children's Hospital, Boston, Massachusetts
- SITTAMPALAM, SITTA, Dept. of Therapeutics, Discovery, and Development, Cancer Center, University of Kansas, Kansas City
- SLATER, JILL, Dept. of Physiology, Wayne State University, Detroit, Michigan
- SMITH, STEPHEN, Dept. of BioScience and BioSurgery, Baxter Healthcare, Round Lake, Illinois

- SOLTER, DAVOR, Agency for Science, Technology and Research, Institute of Medical Biology, Immunology, Singapore
- SONG, KIWON, Dept. of Biochemistry, Yonsei University, Seoul, South Korea
- SONG, YAN, Dept. of Pharmacology, Stony Brook University, Stony Brook, New York
- SOUTHALL, TONY, Dept. of Physiology, Development and Neuroscience, Wellcome Trust Cancer Research, U.K. Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- SPARMANN, ANKE, Div. of Molecular Genetics, Netherlands Cancer Institute, Amsterdam, The Netherlands
- SPECTOR, DAVID, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- SPEES, JEFF, Dept. of Medicine, University of Vermont, Colchester
- SPRADLING, ALLAN, Dept. of Embryology, Carnegie Institution of Washington, Baltimore, Maryland
- STEFANOVIC, SONIA, Institut National de la Santé et de la Recherche Médicale, Unité Mixte de Recherche, University of Evry, Evry, France
- STEWART, DAVID, Meetings and Courses Program, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- STILLMAN, BRUCE, President, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- STRIPP, BARRY, Dept. of Pulmonary, Allergy, and Critical Care, Duke University Medical Center, Durham, North Carolina
- STUDER, LORENZ, Dept. of Developmental Biology, Memorial Sloan-Kettering Cancer Center, New York, New York
- SUBRAMANIAN, VASANTA, Dept. of Biology and Biochemistry, University of Bath, Bath, United Kingdom
- SUETTERLIN, PHILIPP, Wolfson Centre for Age Related Diseases, King's College, London, United Kingdom
- SULLIVAN, GARETH, Center of Regenerative Medicine, Edinburgh University, Edinburgh, Scotland, United Kingdom
- SUN, XUYANG ALFRED, Dept. of Pathology, Stanford University, Stanford, California
- SURANI, AZIM, Wellcome Trust Cancer Research, U.K. Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- SURZENKO, NATALIA, Dept. of Genetics, University of North Carolina, Chapel Hill
- SUTHERLAND, KATE, Div. of Molecular Genetics, Netherlands Cancer Institute, Amsterdam, The Netherlands
- SWEET, DEBORAH, *Developmental Cell*, Cell Press, Cambridge, Massachusetts
- SWINDLE, SCOTT, Dept. of Microbiology, University of Alabama, Birmingham
- SZEKELY, ANNA, Dept. of Genetics and Neurology, School of Medicine, Yale University, New Haven, Connecticut
- TAKACOVA, SYLVIA, Dept. of Biology, Faculty of Medicine, Palacky University, Olomouc, Czech Republic
- TALIB, SOHEL, California Institute for Regenerative Medicine, San Francisco, California
- TALOS, FLAMINIA, Dept. of Pathology, Stony Brook University, Stony Brook, New York
- TAM, PATRICK, Embryology Unit, Children's Medical Research Institute, Westmead, Australia
- TAN, KAH YONG, Dept. of Stem Cells and Development, Joslin Diabetes Center, Boston, Massachusetts
- TANAKA, ELLY, Max-Planck-Institute of Molecular Cell Biology and Genetics, Dresden, Germany
- TAUCHI, TETSUZO, Dept. of Internal Medicine, Tokyo Medical University, Tokyo, Japan
- TAVAZOIE, MASOUD, Dept. of Pathology, Columbia University, New York, New York
- TEE, WEE-WEI, Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- TEISANU, ROXANA, Dept. of Pulmonary, Allergy, and Critical Care, Duke University Medical Center, Durham, North Carolina
- TERSKIKH, ALEXEY, Dept. of Neuroscience, Burnham Institute for Medical Research, La Jolla, California
- TESAR, PAUL, Dept. of Molecular Biology, National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland
- THAL, MELISSA, Dept. of Microbiology, University of Alabama, Birmingham
- THEUNISSEN, JAN-WILLEM, *Nature Biotechnology*, Nature Publishing Group, New York, New York
- THOMPSON, ALYSON, Wellcome Trust Cancer Research, U.K. Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- THORPE, PETER, Dept. of Genetics and Development, Columbia University Medical Center, New York, New York
- TIMMERMANS, MARJA, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- TING, STEPHEN, Dept. of Molecular Genetics of Stem Cells, Institute for Research in Immunology and Cancer, Montréal, Québec, Canada
- TJIAN, ROBERT, Dept. of Molecular and Cell Biology, University of California, Berkeley
- TROTTIER, MAGAN, Dept. of Genetics and Genome Biology, Hospital for Sick Children, University of Toronto, Toronto, Ontario, Canada
- TZENG, RUEI-YING, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- UNGEWITTER, ERICA, Dept. of Molecular Cell and Developmental Biology, University of Virginia, Charlottesville
- VALDIMARSDOTTIR, GUDRUN, Dept. of Biochemistry and Molecular Biology, University of Iceland, Reykjavik, Iceland
- VAN ZOELLEN, E. JOOP, Dept. of Cell Biology, Radboud University of Nijmegen, Nijmegen, The Netherlands
- VEIT, BRUCE, Dept. of Forage Biotechnology, AgResearch, Palmerston North, New Zealand
- VENERE, MONICA, Dept. of Urology, Institute for Regeneration Medicine, University of California, San Francisco
- VERDIN, ERIC, Gladstone Institute of Virology and Immunology, University of California, San Francisco
- VINSON, CHARLES, Lab. of Metabolism, National Institutes of Health, Bethesda, Maryland
- VISVADER, JANE, Royal Melbourne Hospital, The Walter and Eliza Hall Institute of Medical Research, Parkville, Victoria, Australia

SYMPOSIUM PARTICIPANTS

xiii

- VOGT, THOMAS, Dept. of Genetically Engineered Models, Merck Research Laboratories, Rahway, New Jersey
- VOLANAKIS, EMMANUEL, Dept. of Oncology, St. Jude Children's Research Hospital, Memphis, Tennessee
- VOOG, JUSTIN, Lab. of Genetics, The Salk Institute for Biological Studies, La Jolla, California
- VULLIET, RICHARD, Dept. of Veterinary Molecular Biosciences, University of California, Davis
- WADA, NAKO, Pharmacology and Pathology Research Center, Chugai Research Institute for Medical Science, Gotemba, Japan
- WAGERS, AMY, Dept. of Developmental and Stem Cell Biology, Joslin Diabetes Center, Boston, Massachusetts
- WANG, JIALIANG, Dept. of Surgery, Duke University, Durham, North Carolina
- WANG, XIUPING, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts
- WANG, ZHONG, Cardiovascular Research Center, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts
- WATT, FIONA, Li Ka Shing Centre, Cancer Research UK, Cambridge Research Institute, Cambridge, United Kingdom
- WEBB, CAROL, Dept. of Immunobiology and Cancer, Oklahoma Medical Research Foundation, Oklahoma City, Oklahoma
- WEISSMAN, IRVING, Dept. of Pathology, School of Medicine, Stanford University, Stanford, California
- WELNER, ROBERT, Dept. of Immunobiology and Cancer, Oklahoma Medical Research Foundation, Oklahoma City, Oklahoma
- WENEMOSER, DANIELLE, Whitehead Institute for Biomedical Research, Cambridge, Massachusetts
- WICHA, MAX, Comprehensive Cancer Center, University of Michigan, Ann Arbor
- WICHTERLE, HYNEK, Dept. of Pathology, Columbia University, New York, New York
- WIENHOLDS, ERNO, Dept. of Cellular and Molecular Biology, University Health Network, Toronto, Ontario, Canada
- WILLIAMS, RICHARD, Dept. of Oncology, St. Jude Children's Research Hospital, Memphis, Tennessee
- WILSCHUT, KARLIJN, Dept. of Farm Animal Health, Faculty of Veterinary Medicine, Utrecht University, Utrecht, The Netherlands
- WITKOWSKI, JAN, Banbury Center, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- WITTE, OWEN, Dept. of Microbiology, Immunology, and Molecular Genetics, Howard Hughes Medical Institute, University of California, Los Angeles
- WONG, CHRISTINE, Dept. of Obstetrics and Gynecology, Samuel Lunenfeld Research Institute, Toronto, Ontario, Canada
- WOOD, STEPHEN, National Centre for Adult Stem Cell Research, Griffith University, Nathan, Australia
- WU, JIANG, Dept. of Pathology, Howard Hughes Medical Institute, Stanford University, Stanford, California
- WU, PAO-SHU, Wellcome Trust Cancer Research, U.K. Gurdon Institute, University of Cambridge, Cambridge, United Kingdom
- XI, RONGWEN, National Institute of Biological Sciences, Beijing, China
- XIE, TING, Stowers Institute for Medical Research, Kansas City, Missouri
- XU, JIAN, Molecular Biology Institute, University of California, Los Angeles
- XU, NA, Neuroscience Research Institute, University of California, Santa Barbara
- XUAN, ZHENYU, Cold Spring Harbor Laboratory, Cold Spring Harbor, New York
- YAMAGUCHI, TERRY, Lab. of Cancer and Developmental Biology, National Cancer Institute, Frederick, Maryland
- YANG, PETER, Regeneron Pharmaceuticals, Tarrytown, New York
- YANG, ZIPING, Dept. of BioScience, Baxter Healthcare, Round Lake, Illinois
- YOSHIDA, SHOSEI, Dept. of Pathology and Tumor Biology, Graduate School of Medicine, Kyoto University, Kyoto, Japan
- YOUNG, RICHARD, Dept. of Biology, Whitehead Institute for Biomedical Research, Massachusetts Institute of Technology, Cambridge, Massachusetts
- YU, YUNG-LUEN, Graduate Institute of Cancer Biology, China Medical University, Taichung, Taiwan
- YUAN, SHAUNA, Dept. of Neuroscience, University of California at San Diego, La Jolla
- ZABALA UGALDE, MAIDER, Institute for Stem Cell Biology and Regenerative Medicine, Stanford University, Stanford, California
- ZACHAREK, SIMA, Dept. of Hematology and Oncology, Stem Cell Program, Children's Hospital, Harvard Medical School, Boston, Massachusetts
- ZARET, KENNETH, Dept. of Cell and Developmental Biology, Fox Chase Cancer Center, Philadelphia, Pennsylvania
- ZATZ, MARION, Div. of Genetics and Developmental Biology, National Institute of General Medical Sciences, National Institutes of Health, Bethesda, Maryland
- ZENTAR, MARC, Wolfson Centre for Age Related Diseases, King's College London, London, United Kingdom
- ZHANG, GUANGJUN, Koch Institute, Massachusetts Institute of Technology, Cambridge, Massachusetts
- ZHANG, HAIYING, Lab. of Mammalian Cell Biology and Development, Howard Hughes Medical Institute, The Rockefeller University, New York, New York
- ZHANG, SUI, Dept. of Cardiology, M.D. Anderson Cancer Center, University of Texas, Houston
- ZHANG, YANPING, Dept. of Radiation Oncology, University of North Carolina, Chapel Hill
- ZHOU, YAN, Dept. of Molecular, Cellular, and Developmental Biology, Yale University, New Haven, Connecticut
- ZON, LEONARD, Dept. of Hematology, Howard Hughes Medical Institute, Children's Hospital, Boston, Harvard Medical School, Massachusetts
- ZUNINO, FEDERICA, Dept. of Experimental Oncology, European Institute of Oncology, Milan, Italy
- ZWAKA, THOMAS, Dept. of Molecular and Cellular Biology, Baylor College of Medicine, Houston, Texas

Row 1: R. McKay, A. Androutsellis-Theotokus; H. Lin; M. Wicha; B. Stillman, M. Timmermans
 Row 2: Wine and Cheese party; A. Spradling, A. Sánchez Alvarado
 Row 3: T. Grodzicker, C. Sherr; C. Kim, B. Stripp; R. Tjian
 Row 4: E. Fuchs; M. Tavazoie; A. Spradling, J. Greve; J. Adams
 Row 5: Poster Session; Get-together on the beach

Row 1: Participant happy with her caricature; D. Hoepfner, G. Enkilopov; L. Bar, L. Rohrschneider
 Row 2: T. Grodzicker, R. McKay; J. Silveira Botelho, D. Stewart; J. Seita, S. Nishikawa
 Row 3: Picnic
 Row 4: A. Surani, I. Weissman; R. Jaenisch, K. Zaret; B. Hogan, D. Solter

Row 1: K. Janssen, V. Mittal; C. Li, G. Sullivan; K. Zaret, R. Young
Row 2: Symposium Interview—J. Witkowski, B. Hogan; D. Balasubramanian
Row 3: T. Rando, M. Childers; J. Inglis, J. Alfred; S. Aigner, A. Denli
Row 4: T. Vogt, M. Shen; S. Ting, K. Hope
Row 5: Poster Session; I. Ibarra; S. Morrison, K. Helin

Row 1: B. Hogan, E. Fuchs; L.E. O'Brien; A. Economides
Row 2: V. Dubowitz; N. Harter, R. Rothstein; H. Johanssen
Row 3: M. Niki; A. Nakano, W. Lu; B. Seeshi; P. Carroll
Row 4: Walking Tour

Row 1: M. Baron, A. Bank; R. Vulliet; B. Hogan, J. Alfred
 Row 2: L. Zon; N. Siddall, V. Coronas; M. Berta, M. Cals-Grierson
 Row 3: C. Wong, M. Trottier; Symposium Interview—C. Cormier, L. Parada
 Row 4: J. Williams (*right*) with Professor for a Day high school students

Row 1: R. Nusse, T. Zwaka, C. Scherr, M. Fuller; J. Witkowski, E. Tanaka
Row 2: U. Grossniklaus; R. Nusse, T. Yamaguchi; F. Watt; M. Buckingham
Row 3: R. Doerge, R. Martienssen; R. Jaenisch, K. Hochedlinger

Foreword

The roots of stem cell research can be traced back to classical work in embryology and regeneration performed in the 19th century. By the early 1900s, researchers in Europe had come to understand that various types of blood cells were derived from a particular “stem cell,” resulting in physicians’ attempts to administer bone marrow by mouth to patients suffering from anemia and leukemia. Although such therapy was unsuccessful, laboratory experiments eventually demonstrated that mice with defective marrow could be restored to health with infusions into the bloodstream of marrow taken from other mice, stimulating physicians to speculate whether it was feasible to transplant bone marrow from one human to another. By the late 1960s, pioneering work by Till and McCulloch demonstrated the existence of hematopoietic stem cells. Later, bone marrow transplantation (a stem cell transplant) was dogged by problems of histocompatibility, but as the basis of the HLA system became increasingly understood, successful bone marrow transplantation between unrelated individuals was first demonstrated in 1973.

Stem cell research has since exploded, with the derivation of mouse embryonic stem cells in 1981, the culturing of neural stem cells as neurospheres in 1992, and the establishment of the first human embryonic stem cell lines in 1998. A definitive link between stem cells and cancer was established when certain leukemias were shown to originate from hematopoietic stem cells. During the last decade, the concept of adult stem cell plasticity has gained credence, although many findings have proved controversial, and the ethical arguments for and against the use of human embryonic stem cells have been widely debated on national and international levels. Within the last 2 years, it has been reproducibly established that an embryonic stem cell–like state, previously achieved only by somatic cell nuclear transfer into enucleated oocytes (“cloning”) or by fusion with embryonic stem cells, can be induced by reprogramming differentiated adult cells using a simple combination of key transcription factors.

Progress in stem cell research is now extremely intense, with more than 5000 research papers on embryonic and adult stem cells published in reputable scientific journals every year. It therefore seemed appropriate to focus the 73rd Symposium on this important and rapidly developing field, providing a unique synthesis of the exciting progress being made in the field of stem cell biology, not only for the Symposia attendees, but for a wider global audience via interviews freely available on the world wide web, and, we anticipate, for readers of these Proceedings.

In organizing this Symposium, we relied on the assistance of Elaine Fuchs, Rusty Gage, Greg Hannon, Ron McKay, Davor Solter, and Allan Spradling for suggestions for speakers. Opening night speakers included Rudolph Jaenisch, Minx Fuller, Arturo Alvarez-Buylla, and Max Wicha, and Irving Weissman presented the Reginald Harris Lecture on normal and neoplastic stem cells. Elaine Fuchs enlightened a mixed audience of scientists, lay friends, and neighbors with her Dorcas Cummings Lecture on skin stem cells, and Brigid Hogan ended the meeting with a masterful and eloquent Summary.

This Symposium was attended by 465 scientists from more than 30 countries, and the program included 68 oral presentations and 177 poster presentations. We particularly thank the Lisbon-based Champalimaud Foundation for their extensive and generous support of this year’s Symposium. Additional funds to run this meeting were obtained from the National Institutes of Health. Financial support of our meetings program from corporate patrons, benefactors, sponsors, associates, affiliates, contributors, and foundations is essential for these Symposia to remain a success and we are most grateful for their continued support.

We wish to thank Val Pakaluk and Mary Smith in the Meetings and Courses Program office for their efficient help in organizing the Symposium. Joan Ebert and Rena Steuer in the Cold Spring Harbor Laboratory Press, headed by John Inglis, ensured that this volume would be produced. We thank them for their dedication to producing high-quality publications.

Bruce Stillman
David Stewart
Terri Grodzicker
March 2009

Sponsors

The 73rd Symposium was generously supported by the **Champalimaud Foundation**, a Lisbon-based international organization with an ongoing interest in basic and clinical aspects of stem cells.

This meeting was funded in part by the **National Cancer Institute**, a branch of the **National Institutes of Health**.

Contributions from the following companies provide core support for the Cold Spring Harbor meetings program.

Corporate Patron

Pfizer, Inc.

Corporate Benefactors

Amgen, Inc.

GlaxoSmithKline

Merck Research Laboratories

Novartis Institutes for BioMedical Research

Corporate Sponsors

Agilent Technologies

Applied Biosystems

AstraZeneca

BioVentures, Inc.

Bristol-Myers Squibb Company

Genentech, Inc.

Hoffmann-La Roche, Inc.

Invitrogen Corporation

IRX Therapeutics, Inc.

Kyowa Hakko Kogyo Co., Ltd.

New England BioLabs, Inc.

OSI Pharmaceuticals, Inc.

Sanofi-Aventis

Schering-Plough Research Institute

Plant Corporate Associates

Monsanto Company

Pioneer Hi-Bred International, Inc.

Corporate Affiliates

Affymetrix

Corporate Contributors

Epicentre Biotechnologies

Illumina

Foundations

Hudson-Alpha Institute for Biotechnology

Contents

Symposium Participants	v
Foreword	xxi

Germ Cells and Totipotency

Regulating Gene Expression in the <i>Drosophila</i> Germ Line <i>P. Rangan, M. DeGennaro, and R. Lehmann</i>	1
Germ Line, Stem Cells, and Epigenetic Reprogramming <i>M.A. Surani, G. Durcova-Hills, P. Hajkova, K. Hayashi, and W.W. Tee</i>	9
Brief History, Pitfalls, and Prospects of Mammalian Spermatogonial Stem Cell Research <i>M. Kanatsu-Shinohara, M. Takehashi, and T. Shinohara</i>	17
Spermatogenic Stem Cell System in the Mouse Testis <i>S. Yoshida</i>	25
Reprogramming and Differentiation in Mammals: Motifs and Mechanisms <i>W.N. de Vries, A.V. Evsikov, L.J. Brogan, C.P. Anderson, J.H. Graber, B.B. Knowles, and D. Solter</i>	33

Niches and Asymmetry

Interactions between Stem Cells and Their Niche in the <i>Drosophila</i> Ovary <i>T. Xie, X. Song, Z. Jin, L. Pan, C. Weng, S. Chen, and N. Zhang</i>	39
Stem Cells and Their Niches: Integrated Units That Maintain <i>Drosophila</i> Tissues <i>A.C. Spradling, T. Nystul, D. Lighthouse, L. Morris, D. Fox, R. Cox, T. Tootle, R. Frederick, and S. Skora</i>	49
Wnt Signaling and Stem Cell Control <i>R. Nusse, C. Fuerer, W. Ching, K. Harnish, C. Logan, A. Zeng, D. ten Berge, and Y. Kalani</i>	59
Niche Required for Inducing Quiescent Stem Cells <i>S.-I. Nishikawa, M. Osawa, S. Yonetani, S. Torikai-Nishikawa, and R. Freter</i>	67
Asymmetric Division and Stem Cell Renewal without a Permanent Niche: Lessons from Lymphocytes <i>J.T. Chang and S.L. Reiner</i>	73
Modeling Stem Cell Asymmetry in Yeast <i>P.H. Thorpe, J. Bruno, and R. Rothstein</i>	81

Embryonic Development and Multipotent Progenitors

The Maternal to Zygotic Transition in Animals and Plants <i>C. Baroux, D. Autran, C.S. Gillmor, D. Grimanelli, and U. Grossniklaus</i>	89
Directed Differentiation of Pluripotent Stem Cells: From Developmental Biology to Therapeutic Applications <i>S. Irion, M.C. Nostro, S.J. Kattman, and G.M. Keller</i>	101
Regulation of Stem Cells in the Zebra Fish Hematopoietic System <i>H.-T. Huang and L.I. Zon</i>	111
Pioneer Factors, Genetic Competence, and Inductive Signaling: Programming Liver and Pancreas Progenitors from the Endoderm <i>K.S. Zaret, J. Watts, J. Xu, E. Wandzioch, S.T. Smale, and T. Sekiya</i>	119
Generation of Cardiomyocytes from New Human Embryonic Stem Cell Lines Derived from Poor-quality Blastocysts <i>A. Raya, I. Rodríguez-Pizà, B. Arán, A. Consiglio, P.N. Barri, A. Veiga, and J.C. Izpisua Belmonte</i>	127
Regulation of Self-renewal and Differentiation in Adult Stem Cell Lineages: Lessons from the <i>Drosophila</i> Male Germ Line <i>E.L. Davies and M.T. Fuller</i>	137

Reprogramming Somatic Cells

Reprogramming of Somatic Cell Identity <i>J. Hanna, B.W. Carey, and R. Jaenisch</i>	147
Induced Pluripotency of Mouse and Human Somatic Cells <i>N. Maherali and K. Hochedlinger</i>	157
Ronin and Caspases in Embryonic Stem Cells: A New Perspective on Regulation of the Pluripotent State <i>T.P. Zwaka</i>	163

Common Themes of Dedifferentiation in Somatic Cell Reprogramming and Cancer	<i>G.Q. Daley</i>	171
Pathways to New β Cells	<i>Q. Zhou and D.A. Melton</i>	175
Gene Expression and Transcriptional Networks		
Mapping Key Features of Transcriptional Regulatory Circuitry in Embryonic Stem Cells	<i>M.F. Cole and R.A. Young</i>	183
The Transcriptional Network Controlling Pluripotency in ES Cells	<i>S.H. Orkin, J. Wang, J. Kim, J. Chu, S. Rao, T.W. Theunissen, X. Shen, and D.N. Levasseur</i>	195
Transcriptional Regulatory Networks in Embryonic Stem Cells	<i>X. Chen, V.B. Vega, and H.-H. Ng</i>	203
Toward Stem Cell Systems Biology: From Molecules to Networks and Landscapes	<i>B.D. MacArthur, A. Ma'ayan, and I.R. Lemischka</i>	211
An Unexpected Role of TAFs and TRFs in Skeletal Muscle Differentiation: Switching Core Promoter Complexes	<i>M.D.E. Deato and R. Tjian</i>	217
Stemness Is Only a State of the Cell	<i>M.N. Kagalwala, S.K. Singh, and S. Majumder</i>	227
Epigenetics		
Stem Cell Factors in Plants: Chromatin Connections	<i>N. Kornet and B. Scheres</i>	235
Genetic and Epigenetic Regulation of Stem Cell Homeostasis in Plants	<i>M. Lodha, C.F. Marco, and M.C.P. Timmermans</i>	243
Regulation of Stem Cell Differentiation by Histone Methyltransferases and Demethylases	<i>D. Pasini, A.P. Bracken, K. Agger, J. Christensen, K. Hansen, P.A.C. Cloos, and K. Helin</i>	253
Epigenetic Inheritance and Reprogramming in Plants and Fission Yeast	<i>R.A. Martienssen, A. Kloc, R.K. Slotkin, and M. Tanurdžić</i>	265
A Novel Epigenetic Mechanism in <i>Drosophila</i> Somatic Cells Mediated by PIWI and piRNAs	<i>H. Lin and H. Yin</i>	273
Small RNA Silencing Pathways in Germ and Stem Cells	<i>A.A. Aravin and G.J. Hannon</i>	283
Adult Stem Cells		
Epithelial Stem/Progenitor Cells in Lung Postnatal Growth, Maintenance, and Repair	<i>E.L. Rawlins, T. Okubo, J. Que, Y. Xue, C. Clark, X. Luo, and B.L.M. Hogan</i>	291
Multipotent Islet-1 Cardiovascular Progenitors in Development and Disease	<i>A. Nakano, H. Nakano, and K.R. Chien</i>	297
Regulation of Skeletal Muscle Stem Cell Behavior by Pax3 and Pax7	<i>M. Lagha, T. Sato, L. Bajard, P. Daubas, M. Esner, D. Montarras, F. Relaix, and M. Buckingham</i>	307
Regulation and Function of Skeletal Muscle Stem Cells	<i>M. Cerletti, J.L. Shadrach, S. Jurga, R. Sherwood, and A.J. Wagers</i>	317
The Molecular Regulation of Muscle Stem Cell Function	<i>M.A. Rudnicki, F. Le Grand, I. McKinnell, and S. Kuang</i>	323
Building Epithelial Tissues from Skin Stem Cells	<i>E. Fuchs and J.A. Nowak</i>	333
Very Long-term Self-renewal of Small Intestine, Colon, and Hair Follicles from Cycling <i>Lgr5</i> ⁺ Stem Cells	<i>N. Barker, J.H. van Es, V. Jaks, M. Kasper, H. Snippert, R. Toftgård, and H. Clevers</i>	351
Neural Stem Cells and Brain Tumors		
The Heterogeneity of Adult Neural Stem Cells and the Emerging Complexity of Their Niche	<i>A. Alvarez-Buylla, M. Kohwi, T.M. Nguyen, and F.T. Merkle</i>	357
Notch, Neural Stem Cells, and Brain Tumors	<i>T.J. Pierfelice, K.C. Schreck, C.G. Eberhart, and N. Gaiano</i>	367
Human ESC-derived Neural Rosettes and Neural Stem Cell Progression	<i>Y. Elkabetz and L. Studer</i>	377
Metabolomics of Neural Progenitor Cells: A Novel Approach to Biomarker Discovery	<i>M. Maletić-Savatić, L.K. Vingara, L.N. Manganas, Y. Li, S. Zhang, A. Sierra, R. Hazel, D. Smith, M.E. Wagshul, F. Henn, L. Krupp, G. Enikolopov, H. Benveniste, P. Djurić, and I. Pelczer</i>	389
Signaling Pathways Controlling Neural Stem Cells Slow Progressive Brain Disease	<i>A. Androutsellis-Theotokis, M.A. Rueger, H. Mkhikian, E. Korb, and R.D.G. McKay</i>	403

CONTENTS

xxv

Cancer Stem Cells in Brain Tumor Biology <i>J.N. Rich and C.E. Eyler</i>	411
Neural and Cancer Stem Cells in Tumor Suppressor Mouse Models of Malignant Astrocytoma <i>S. Alcantara Llaguno, J. Chen, C.-H. Kwon, and L.F. Parada</i>	421
Pten and p53 Converge on c-Myc to Control Differentiation, Self-renewal, and Transformation of Normal and Neoplastic Stem Cells in Glioblastoma <i>H. Zheng, H. Ying, H. Yan, A.C. Kimmelman, D.J. Hiller, A.-J. Chen, S.R. Perry, G. Tonon, G.C. Chu, Z. Ding, J.M. Stommel, K.L. Dunn, R. Wiedemeyer, M.J. You, C. Brennan, Y.A. Wang, K.L. Ligon, W.H. Wong, L. Chin, and R.A. DePinho</i>	427
Stem Cells and Cancer	
Establishment of a Normal Hematopoietic and Leukemia Stem Cell Hierarchy <i>M.P. Chao, J. Seita, and I.L. Weissman</i>	439
Role of “Cancer Stem Cells” and Cell Survival in Tumor Development and Maintenance <i>J.M. Adams, P.N. Kelly, A. Dakic, S. Carotta, S.L. Nutt, and A. Strasser</i>	451
The <i>INK4-ARF</i> (<i>CDKN2A/B</i>) Locus in Hematopoiesis and BCR-ABL–induced Leukemias <i>R.T. Williams and C.J. Sherr</i>	461
Delineating the Epithelial Hierarchy in the Mouse Mammary Gland <i>M.-L. Asselin-Labat, F. Vaillant, M. Shackleton, T. Bouras, G.J. Lindeman, and J.E. Visvader</i>	469
Stem Cell Biology in the Lung and Lung Cancers: Using Pulmonary Context and Classic Approaches <i>D.M. Raiser, S.J. Zacharek, R.R. Roach, S.J. Curtis, K.W. Sinkevicius, D.W. Gludish, and C.F. Kim</i>	479
Epithelial Stem Cells of the Prostate and Their Role in Cancer Progression <i>R.U. Lukacs, D.A. Lawson, L. Xin, Y. Zong, I. Garraway, A.S. Goldstein, S. Memarzadeh, and O.N. Witte</i>	491
Role of β -catenin in Epidermal Stem Cell Expansion, Lineage Selection, and Cancer <i>F.M. Watt and C.A. Collins</i>	503
Implications of Cellular Senescence in Tissue Damage Response, Tumor Suppression, and Stem Cell Biology <i>V. Krizhanovsky, W. Xue, L. Zender, M. Yon, E. Hernando, and S.W. Lowe</i>	513
Renewal and Regeneration	
Regulation of Self-renewal and Differentiation in the <i>Drosophila</i> Nervous System <i>T.D. Southall, B. Egger, K.S. Gold, and A.H. Brand</i>	523
Progenitor Cells for the Prostate Epithelium: Roles in Development, Regeneration, and Cancer <i>M.M. Shen, X. Wang, K.D. Economides, D. Walker, and C. Abate-Shen</i>	529
Stem Cells Use Distinct Self-renewal Programs at Different Ages <i>B.P. Levi and S.J. Morrison</i>	539
Complementary and Independent Function for <i>Hoxb4</i> and <i>Bmi1</i> in HSC Activity <i>A. Faubert, J. Chagraoui, N. Mayotte, M. Fréchette, N.N. Iscove, R.K. Humphries, and G. Sauvageau</i>	555
Regeneration, Stem Cells, and the Evolution of Tumor Suppression <i>B.J. Pearson and A. Sánchez Alvarado</i>	565
Germ Cell Specification and Regeneration in Planarians <i>P.A. Newmark, Y. Wang, and T. Chong</i>	573
Novel Insights into the Flexibility of Cell and Positional Identity during Urodele Limb Regeneration <i>M. Kragl, D. Knapp, E. Nacu, S. Khattak, E. Schnapp, H.-H. Epperlein, and E.M. Tanaka</i>	583
Summary: Present and Future Challenges for Stem Cell Research <i>B.L.M. Hogan</i>	593
Author Index	601
Subject Index	603

Cold Spring Harbor Symposia on Quantitative Biology

Front Matter

Bruce Stillman, David Stewart and Terri Grodzicker

Cold Spring Harb Symp Quant Biol 2008 73: xxi

Access the most recent version at doi:[10.1101/s73/foreword](https://doi.org/10.1101/s73/foreword)

License

Email Alerting Service

Receive free email alerts when new articles cite this article - sign up in the box at the top right corner of the article or [click here](#).

To subscribe to *Cold Spring Harbor Symposia on Quantitative Biology* go to:
<http://symposium.cshlp.org/subscriptions>