**COLD SPRING HARBOR SYMPOSIA
ON QUANTITATIVE BIOLOGY
VOLUME LXXVII**

symposium.cshlp.org

Please visit our website at symposium.cshlp.org for online access.

**COLD SPRING HARBOR SYMPOSIA
ON QUANTITATIVE BIOLOGY**

VOLUME LXXVII

The Biology of Plants

symposium.cshlp.org

Meeting organized by Terri Grodzicker, Robert Martienssen, David Stewart, and Bruce Stillman
COLD SPRING HARBOR LABORATORY PRESS
2012

COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY VOLUME LXXVII

© 2012 by Cold Spring Harbor Laboratory Press

International Standard Book Number 978-1-621820-25-3 (cloth)

International Standard Book Number 978-1-621820-26-0 (paper)

International Standard Serial Number 0091-7451

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	XXXVIII (1973) Chromosome Structure and Function
II (1934) Aspects of Growth	XXXIX (1974) Tumor Viruses
III (1935) Photochemical Reactions	XL (1975) The Synapse
IV (1936) Excitation Phenomena	XLI (1976) Origins of Lymphocyte Diversity
V (1937) Internal Secretions	XLII (1977) Chromatin
VI (1938) Protein Chemistry	XLIII (1978) DNA: Replication and Recombination
VII (1939) Biological Oxidations	XLIV (1979) Viral Oncogenes
VIII (1940) Permeability and the Nature of Cell Membranes	XLV (1980) Movable Genetic Elements
IX (1941) Genes and Chromosomes: Structure and Organization	XLVI (1981) Organization of the Cytoplasm
X (1942) The Relation of Hormones to Development	XLVII (1982) Structures of DNA
XI (1946) Heredity and Variation in Microorganisms	XLVIII (1983) Molecular Neurobiology
XII (1947) Nucleic Acids and Nucleoproteins	XLIX (1984) Recombination at the DNA Level
XIII (1948) Biological Applications of Tracer Elements	L (1985) Molecular Biology of Development
XIV (1949) Amino Acids and Proteins	LI (1986) Molecular Biology of Homo sapiens
XV (1950) Origin and Evolution of Man	LII (1987) Evolution of Catalytic Function
XVI (1951) Genes and Mutations	LIII (1988) Molecular Biology of Signal Transduction
XVII (1952) The Neuron	LIV (1989) Immunological Recognition
XVIII (1953) Viruses	LV (1990) The Brain
XIX (1954) The Mammalian Fetus: Physiological Aspects of Development	LVI (1991) The Cell Cycle
XX (1955) Population Genetics: The Nature and Causes of Genetic Variability in Population	LVII (1992) The Cell Surface
XXI (1956) Genetic Mechanisms: Structure and Function	LVIII (1993) DNA and Chromosomes
XXII (1957) Population Studies: Animal Ecology and Demography	LVIX (1994) The Molecular Genetics of Cancer
XXIII (1958) Exchange of Genetic Material: Mechanism and Consequences	LX (1995) Protein Kinesis: The Dynamics of Protein Trafficking and Stability
XXIV (1959) Genetics and Twentieth Century Darwinism	LXI (1996) Function & Dysfunction in the Nervous System
XXV (1960) Biological Clocks	LXII (1997) Pattern Formation during Development
XXVI (1961) Cellular Regulatory Mechanisms	LXIII (1998) Mechanisms of Transcription
XXVII (1962) Basic Mechanisms in Animal Virus Biology	LXIV (1999) Signaling and Gene Expression in the Immune System
XXVIII (1963) Synthesis and Structure of Macromolecules	LXV (2000) Biological Responses to DNA Damage
XXIX (1964) Human Genetics	LXVI (2001) The Ribosome
XXX (1965) Sensory Receptors	LXVII (2002) The Cardiovascular System
XXXI (1966) The Genetic Code	LXVIII (2003) The Genome of Homo sapiens
XXXII (1967) Antibodies	LXIX (2004) Epigenetics
XXXIII (1968) Replication of DNA in Microorganisms	LXX (2005) Molecular Approaches to Controlling Cancer
XXXIV (1969) The Mechanism of Protein Synthesis	LXXI (2006) Regulatory RNAs
XXXV (1970) Transcription of Genetic Material	LXXII (2007) Clocks and Rhythms
XXXVI (1971) Structure and Function of Proteins at the Three-dimensional Level	LXXIII (2008) Control and Regulation of Stem Cells
XXXVII (1972) The Mechanism of Muscle Contraction	LXXIV (2009) Evolution: The Molecular Landscape
	LXXV (2010) Nuclear Organization and Function
	LXXVI (2011) Metabolism and Disease

Front cover (paperback): Pea plant three-dimensional rendering by James Whitaker, Cold Spring Harbor Laboratory, inspired by Gregor Mendel, the 19th-century Austrian monk whose breeding experiments with garden peas led him to formulate the basic laws of heredity.

Back cover (paperback): *Pisum sativum* by Otto Wilhelm Thomé: *Flora von Deutschland, Österreich und der Schweiz* (1885).

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 www.copyright.com.

For a complete catalog of all Cold Spring Harbor Laboratory Press publications, visit our website at www.cshlpress.org.

Symposium Participants

- ACH, ROBERT, Agilent Technologies, Santa Clara, California
 ALFRED, JANE, *PLoS Biology*, Cambridge, United Kingdom
 AMASINO, RICHARD, Biochemistry, University of Wisconsin, Madison
 ANDERSON, BRUCE, Planreal AG, Keilor, Victoria, Australia
 ANDERSON, MARILYN, School of Biochemistry, LaTrobe University, Bundoora, Australia
 ANGENON, GEERT, Plant Genetics, Vrije Universiteit Brussel, Brussels, Belgium
 ASCENZI, ROBERT, Research, BASF Plant Science, Research Triangle Park, North Carolina
 ASHFIELD, TOM, Biology, Indiana University, Bloomington
 ASSADI, AMIR, Mathematics, The Genome Center of Wisconsin, University of Wisconsin, Madison
 ATALLAH, NADIA, Botany and Plant Pathology, Purdue University, West Lafayette, Indiana
 BAI, YANG, Horticulture, Cornell University, Geneva, New York
 BAILEY-SERRES, JULIA, Botany and Plant Sciences, University of California, Riverside
 BALKUNDE, RACHAPPA, Plant Biology, Cold Spring Harbor Laboratory, New York
 BALSEMAO-PIRES, EMILIA, Instituto de Bioquímica Médica, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
 BANASIAK, JOANNA, Plant Molecular Physiology, Institute of Bioorganic Chemistry, PAS, Poznan, Poland
 BANKS, JODY, Botany, Purdue University, W. Lafayette, Indiana
 BAO, YUN, Plant Biology, Carnegie Institution for Science, Stanford, California
 BARBER, JAMES, Division of Molecular Biosciences, Imperial College London, United Kingdom
 BARTON, KATHRYN, Plant Biology, Carnegie Institution for Science, Stanford, California
 BAUER, MATTHEW, GBE, Monsanto Company, St. Louis, Missouri
 BAULCOMBE, DAVID, Plant Sciences, University of Cambridge, United Kingdom
 BECKER, KATIA, IBBP, University of Münster, Germany
 BENFEY, PHILIP, Biology, Duke University, Durham, North Carolina
 BERGER, FREDERIC JACQUES, Temasek Life Sciences Laboratory, National University of Singapore
 BERGMANN, DOMINIQUE, Biology, Stanford University, California
 BERNAD, LUCIA, Plant Molecular Biology, The Rockefeller University, New York
 BERNDT, HEIKE, Genetics, Martin-Luther University, Halle, Germany
 BILSBOROUGH, GEMMA, Biomed Central, London
 BLEEKER, PETRA, Plant Physiology, University of Amsterdam, The Netherlands
 BOLON, YUNG-TSI, Agronomy and Plant Genetics, University of Minnesota, St. Paul
 BOMFIM, ANNA CAROLINA, Instituto de Bioquímica Médica, Universidade Federal do Rio de Janeiro, Brazil
 BOMMERT, PETER, Delbrück, Cold Spring Harbor Laboratory, New York
 BOTTINO, MARIANA, Biochemistry, Federal University of Rio de Janeiro, Brazil
 BRUSSLAN, JUDY, Biological Sciences, California State University, Long Beach
 BRUTNELL, THOMAS, Donald Danforth Plant Science Center, St. Louis, Missouri
 BULLA, LEE, Molecular and Cell Biology, University of Texas, Dallas, Richardson
 CALARCO, JOSEPH, Watson School of Biological Science, Cold Spring Harbor Laboratory, New York
 CARNEIRO, NEWTON, Molecular Biology, EMBRAPA, Sete Lagoas, Brazil
 CARTER, CLAY, Biology, University of Minnesota, Duluth
 CEDERHOLM, HEIDI, Biology, Duke University, Durham, North Carolina
 CHAI, MAOFENG, Forage Improvement Division, The Samuel Roberts Noble Foundation, Ardmore, Oklahoma
 CHAPARRO-GARCIA, ANGELA, The Sainsbury Laboratory, Norwich, United Kingdom
 CHEN, INES, NSMB, Nature Structural and Molecular Biology, New York
 CHEN, XUEMEI, Botany and Plant Sciences, University of California, Riverside
 CHIA, JER-MING, Ware Laboratory, Cold Spring Harbor Laboratory, New York
 CHORY, JOANNE, Plant Biology Laboratory/HHMI, The Salk Institute for Biological Studies, La Jolla, California
 COLOT, VINCENT, Institut de Biologie de l'Ecole Normale Supérieure, CNRS UMR8197 INSERM U1024, Paris, France
 CORUH, CEYDA, Biology, Pennsylvania State University, State College
 COURBOT, MIKAEL, Biological Sciences, Syngenta Ltd, Stein, Switzerland
 CRAWFORD, BRIAN, Biology, University of California, San Diego
 CREASEY, KATE, Plant Genetics, Cold Spring Harbor Laboratory, New York
 DANGEL, JEFFREY, Biology, University of North Carolina, Chapel Hill
 DE FOLTER, STEFAN, Langebio, CINVESTAV-IPN, Irapuato, Mexico
 DE MEZER, MATEUSZ, Functional Genomics, Institute of Plant Genetics, PAS, Poznan, Poland
 DE SOUSA BORGES, FILIPE, Martienssen Laboratory, Cold Spring Harbor Laboratory, New York
 DEMESA-ARÉVALO, EDGAR, Langebio Department of Genetic Engineering, CINVESTAV-Irapuato, Mexico
 DENG, XING-WANG, Biology, Yale University, New Haven, Connecticut
 DICKSON, LYNDA, Crop Genetics-Regulatory, DuPont-Pioneer, Wilmington, Delaware
 DIXELIUS, CHRISTINA, Plant Biology and Forest Genetics, SLU Swedish University of Agricultural Sciences, Uppsala, Sweden
 DOEBLEY, JOHN, Genetics, University of Wisconsin, Madison
 DOLAN (SOLTAU), WHITNEY, Biochemistry, Purdue University, West Lafayette, Indiana
 DONG, JUAN, Waksman Institute, Rutgers University, Piscataway, New Jersey
 DONG, XINNAN, Biology, Duke University, Durham, North Carolina
 DONOGHUE, MARK, Martienssen Laboratory, Cold Spring Harbor Laboratory, New York
 DOTTO, MARCELA, Plant Biology, Cold Spring Harbor Laboratory, New York
 DUAN, LINA, Plant Biology, Carnegie Institution for Science, Stanford, California
 DUBIN, MANU, Nordborg Group, Gregor Mendel Institute, Vienna, Austria
 ECKARDT, NANCY, The Plant Cell, American Society of Plant Biologists, Fort Collins, Colorado
 ECKER, JOSEPH, Genomic Analysis Laboratory, HHMI/The Salk Institute, La Jolla, California
 EMBER, BRIAN, Technology Acquisition, BASF, Research Triangle Park, North Carolina
 ERHARDT, MATTHIAS, Plant Physiology and Biochemistry, University of Konstanz, Germany
 ERNST, EVAN, Martienssen Laboratory, Cold Spring Harbor Laboratory, New York
 ESTELLE, MARK, Estelle Laboratory, University of California, San Diego, La Jolla
 EVELAND, ANDREA, Plant Genetics/Genomics, Cold Spring Harbor Laboratory, New York

- FANG, YUDA, National Key Laboratory of Plant Molecular Genetics, Shanghai Institute of Plant Physiology and Ecology, China
- FEIJÓ, JOSE, Instituto Gulbenkian Ciencia, University of Lisbon, Oeiras, Portugal
- FENG, XIAOQI, Plant and Microbial Biology, University of California, Berkeley
- FERRO DIAZ, NOEL, Mulliken Center for Theoretical Chemistry, University of Bonn, Germany
- FINIGAN, PATRICK, Watson School for Biological Sciences, Cold Spring Harbor Laboratory, New York
- FREEDMAN, ROGER, Sainsbury Laboratory, Gatsby Foundation, University of Cambridge, United Kingdom
- FROMMER, WOLF, Plant Biology, Carnegie Institution, Stanford, California
- FU, YU, Integrated Genetics, National Institute of Genetics, Mishima, Japan
- FURNES, CLEMENS, Centre for Organelle Research (CORE), University of Stavanger, Norway
- GALIBA, GABOR, Faculty of Information Technology, University of Pannonia, Veszprém, Hungary
- GALLAVOTTI, ANDREA, Waksman Institute of Microbiology, Rutgers University, Piscataway, New Jersey
- GEHRING, MARY, Whitehead Institute, Massachusetts Institute of Technology, Cambridge
- GELDNER, NIKO, Plant Cell Biology, DBMV, University of Lausanne, Switzerland
- GENG, YU, Plant Biology, Carnegie Institution for Science, Stanford, California
- GERMAIN, HUGO, Natural Resources, Laurentian Forestry Center, Québec, Canada
- GONG, ZHIZHONG, College of Biological Sciences, China Agricultural University, Beijing
- GOTO, DEREK, Faculty of Agriculture, Hokkaido University, Sapporo, Japan
- GRANT, SARAH, Biology, University of North Carolina, Chapel Hill
- GRAY, JOHN, Hematology, St. Jude Children's Research Hospital, Memphis, Tennessee
- GRIKO, NATALYA, Molecular and Cell Biology, University of Texas, Dallas, Richardson
- GRODZICKER, TERRI, James Laboratory, Cold Spring Harbor Laboratory, New York
- GROSS, STEPHEN, Genomics, DOE Joint Genome Institute, Walnut Creek, California
- GROSSNIKLAUS, UELI, Institute of Plant Biology, University of Zürich, Switzerland
- GULINA, IRINA, School of Medicine, SUNY Stony Brook, Setauket, New York
- GUSEMAN, JESSICA, Biology, University of Washington, Seattle
- GUTIERREZ, RODRIGO, Molecular Genetics and Microbiology, Pontificia Universidad Católica de Chile, Santiago
- HACHEZ, CHARLES, Institut des Sciences de la Vie, Université Catholique de Louvain, Louvain-la-Neuve, Belgium
- HAKE, SARAH, Plant and Microbial Biology, Gene Expression Center, USDA, University of California, Albany
- HALKIER, BARBARA, Plant Biology and Biotechnology, University of Copenhagen, Frederiksberg
- HAN, JONG JIN, Plant Biology, Cold Spring Harbor Laboratory, New York
- HARMER, STACEY, Plant Biology, University of California, Davis
- HAVELDA, ZOLTÁN, Plant Biotechnology Institute, Agricultural Biotechnology Center, Godollo, Hungary
- HAY, JORDAN, Biology Department, Brookhaven National Laboratory, Upton, New York
- HEILMANN, MONIKA, MVLS, University of Glasgow, Scotland
- HEPWORTH, SHELLEY, Biology, Carleton University, Ottawa, Ontario, Canada
- HERRE, EDWARD, Smithsonian Tropical Research Institute, Washington, DC
- HIENO, AYAKA, Faculty of Applied Biological Science, Gifu University, Japan
- HOWARD, MARTIN, Genome Centre, John Innes Center, Norwich, United Kingdom
- HOWELL, STEPHEN, Plant Sciences Institute, Iowa State University, Ames
- HUA, JIAN, Plant Biology, Cornell University, Ithaca, New York
- HUMBERT, SABRINA, Agronomic Traits, Pioneer Hi-Bred International, Johnston, Iowa
- HUNTER, BEN, Organismic and Evolutionary Biology, Harvard University, Cambridge, Massachusetts
- HUSBANDS, AMAN, Plant Genetics, Cold Spring Harbor Laboratory, New York
- IBRAHIM, MOHAMED, Molecular and Cell Biology, University of Texas, Dallas, Richardson
- INAGAKI, SOICHI, Integrated Genetics, National Institute of Genetics, Mishima, Shizuoka, Japan
- ISHIKAWA, KAZUYA, Advanced Bioscience, Faculty of Agriculture, Kinki University, Nara, Japan
- IURIE, VANESSA, Instituto de Bioquímica Médica—CCS, Universidade Federal do Rio de Janeiro, Brazil
- IZAGUIRRE-SIERRA, MARIO, Embryology, Carnegie Institution, Baltimore, Maryland
- JACKSON, DAVID, Delbrück Laboratory, Cold Spring Harbor Laboratory, New York
- JACKSON, STEPHEN, School of Life Sciences, University of Warwick, Coventry, United Kingdom
- JACOB, YANNICK, Plant Biology, Cold Spring Harbor Laboratory, New York
- JACOBSEN, STEVE, Molecular, Cell, and Developmental Biology, University of California, Los Angeles
- JAKIMO, ALAN, Law, Hofstra University, Woodbury, New York
- JANDER, GEORG, Boyce Thompson Institute for Plant Research, Ithaca, New York
- JASINSKI, MICHAŁ, Plant Molecular Physiology, Institute of Bioorganic Chemistry, PAS, Poznań, Poland
- JAVELLE, MARIE, Timmermans Laboratory, Cold Spring Harbor Laboratory, New York
- JENIK, PABLO, Biology, Franklin & Marshall College, Lancaster, Pennsylvania
- JIANG, KE, Plant Molecular Biology and Genetics, Cold Spring Harbor Laboratory, New York
- JONES, JONATHAN, Sainsbury Laboratory, John Innes Institute, Norwich, United Kingdom
- JORGENSEN, MORTEN, Plant Biology and Biotechnology, University of Copenhagen, Frederiksberg
- KAKUTANI, TETSUJI, Integrative Genetics, National Institute of Genetics, Mishima, Shizuoka, Japan
- KAMOUN, SOPHIEN, The Sainsbury Laboratory, Norwich, United Kingdom
- KANAOKA, MASAHIRO, Graduate School of Science, Nagoya University, Nagoya, Japan
- KANDOTH, PRAMOD, Division of Plant Sciences, University of Missouri, Columbia
- KANG, CHUNYING, Cell Biology and Molecular Genetics, University of Maryland, College Park
- KAPLAN, FATMA, Chemistry Unit, USDA-ARS, Gainesville, Florida
- KAWASAKI, TSUTOMU, Graduate School of Agriculture, Kinki University, Nara, Japan
- KIM, HYUNMIN, Life Science, POSTECH, Pohang, South Korea
- KIM, JEONG IM, Life Science, Purdue University, West Lafayette, Indiana
- KIM, YVONNE, Life Science, University of California, Berkeley
- KINOSHITA, NATSUKO, Plant Molecular Biology, The Rockefeller University, New York
- KIRST, MATIAS, Genetics Institute, University of Florida, Gainesville
- KJELLBOM, PER, Biochemistry and Structural Biology, Lund University, Sweden
- KLESSIG, DANIEL, Boyce Thompson Institute for Plant Research, Ithaca, New York
- KLUMAS, CURTIS, Plant Pathology, Virginia Polytechnic Institute and State University, Blacksburg
- KOTAKIS, CHRISTOS, Biology, University of Crete, Gastouni Ilea, Greece
- KUHLEMEIER, CRIS, Institute of Plant Sciences, University of Bern, Switzerland
- KUMARI, SUNITA, Genomics, Cold Spring Harbor Laboratory, New York
- KURAPARTHY, VASU, Crop Science, North Carolina State University, Raleigh
- KWAK, SU-HWAN, Biology, Long Island University, Brooklyn, New York
- KYOZUKA, JUNKO, Graduate School of Agriculture and Life Sciences, The University of Tokyo, Japan

SYMPOSIUM PARTICIPANTS

vii

- LAURIE, JOHN, Plant Sciences, University of Arizona, Tucson
- LAUX, THOMAS, Biology, University of Freiburg, Germany
- LEE, HORIM, Molecular Biology, Massachusetts General Hospital, Boston
- LEE, YOUNG KOUNG, Molecular Biology, Cold Spring Harbor Laboratory, New York
- LEISNER, COURTNEY, Plant Biology, University of Illinois Urbana Champaign
- LEYSEY, OTTOLINE, Cambridge University, United Kingdom
- LI, JIGANG, MCD Biology, Yale University, New Haven, Connecticut
- LI, LI, Molecular Biology, Massachusetts General Hospital, Boston
- LI, NING, Division of Life Science, The Hong Kong University of Science and Technology, China
- LI, XIAOPING, Biological Sciences, University of Wisconsin, Milwaukee
- LI, XIN, Botany, University of British Columbia, Vancouver
- LIBERATORE, KATIE, Watson School of Biological Sciences, Cold Spring Harbor Laboratory, New York
- LIPPMAN, ZACHARY, Plant Genetics, Cold Spring Harbor Laboratory, New York
- LISERON-MONFILS, CHRISTOPHE, Plant Biology, Cold Spring Harbor Laboratory, New York
- LIU, CHANG-JUN, Biology, Brookhaven National Laboratory, Upton, New York
- LIU, ZHAN-BIN, DuPont Agricultural Biotechnology, DuPont-Pioneer, Wilmington, Delaware
- LODHA, MUKESH, Plant Genetics, Cold Spring Harbor Laboratory, New York
- LOHMANN, JAN, Stem Cell Biology, Heidelberg Institute of Zoology, Germany
- LONG, JEFFREY, Biological Sciences, The Salk Institute for Biological Studies, La Jolla, California
- LU, ZHENYUAN, Ware Laboratory, Cold Spring Harbor Laboratory, New York
- MACALISTER, CORA, Plant Sciences, Cold Spring Harbor Laboratory, New York
- MADSEN, SVEND, Plant Biology and Biotechnology, University of Copenhagen, Frederiksberg
- MAJOVSKI, ROBERT, Cold Spring Harbor Laboratory Press, Genome Research, Woodbury, New York
- MALOOF, JULIN, Plant Biology, University of California, Davis
- MANN, VARDIA, Genetics, Life-Science Institute, The Hebrew University of Jerusalem, Israel
- MARCUS, EMILIE, *Cell Press*, Cambridge, Massachusetts
- MARIMUTHU, MOHAN PREM ANAND, Plant Biology, HHMI/University of California, Davis
- MARON, LYZA, The Robert W. Holley Center for Agriculture and Health, USDA-ARS, Ithaca, New York
- MARTIENSSSEN, ROBERT, Delbrück Laboratory, Cold Spring Harbor Laboratory, New York
- MATSUBARA, SHIZUE, Insitute of Bio- and Geosciences Plant Sciences (IBG-2), Pflanzenwissenschaften, Forschungszentrum Juelich, Germany
- MATTOZZI, MATTHEW, Wyss Institute, Harvard University, Boston, Massachusetts
- MATZKE, MARJORI, Gregor Mendel Institute of Molecular Plant Biology, Austrian Academy of Sciences, Vienna
- MAYFIELD, STEPHEN, Biological Sciences, University of California, San Diego, La Jolla
- MAZUR, BARBARA, Research Strategy, DuPont-Pioneer, Wilmington, Delaware
- MEJIA, LUIS, Smithsonian Tropical Research Institute, Smithsonian Institution, Panama
- MELNYK, CHARLES, The Sainsbury Laboratory, University of Cambridge, United Kingdom
- METEIGNIER, LOUIS-VALENTIN, Biologie, Université de Sherbrooke, Quebec, Canada
- MEYERS, BLAKE, Plant and Soil Sciences, University of Delaware, Newark
- MOGG, ULRIKE, Physiology and Biochemistry of Plants, University of Konstanz, Germany
- MOLLA MORALES, ALMUDENA, Martienssen Laboratory, Cold Spring Harbor Laboratory, New York
- MONACO, MARCELA, Bioinformatics, Cold Spring Harbor Laboratory, New York
- MONFARED, MONA, PGEC/PMB, University of California Berkeley, Albany
- MOODY, LAURA, Plant Sciences, University of Oxford, United Kingdom
- MOSHER, REBECCA, Plant Sciences, University of Arizona, Tucson
- NAM, HONG-GIL, I-BIO, POSTECH, Pohang, South Korea
- NATESAN, SUDHAKAR, DOE-Plant Research Laboratory, Michigan State University, East Lansing
- NELSON, SVEN, Molecular Plant Sciences, Washington State University, Pullman
- NOKHRINA, KATERYNA, Seed Systems, National Research Council, Saskatoon, Canada
- NORTHOVER, CARRIE, Biology, Stanford University, California
- NOUTSOS, CHRISTOS, Ware Laboratory, Computational Biology Postdoc, Cold Spring Harbor Laboratory, New York
- OHME-TAKAGI, MASARU, Bioproduction Research Institute, National Institute of Advanced Industrial Science, Tsukuba, Japan
- PADDACK, TERENCE, Molecular and Cell Biology, University of Texas, Dallas, Richardson
- PARK, SOONJU, Plant Biology, Cold Spring Harbor Laboratory, New York
- PASTERNAK, SHIRAN, Ware Laboratory, Cold Spring Harbor Laboratory, New York
- PASZKOWSKI, JERZY, Plant Biology, University of Geneva, Switzerland
- PAUTLER, MICHAEL, Watson School of Biological Sciences, Cold Spring Harbor Laboratory, New York
- PEROCHON, ALEXANDRE, School of Biology and Environmental Science, University College Dublin, Ireland
- PETSCH, KATIE, Plant Biology, Cold Spring Harbor Laboratory, New York
- PIKAARD, CRAIG, Molecular and Cellular Biochemistry, Indiana University, Bloomington
- PLAVSKIN, YEVGENIY, Cold Spring Harbor Laboratory, New York
- POETHIG, SCOTT, Biology, University of Pennsylvania, Philadelphia
- POLLOCK, MILA, Library, Cold Spring Harbor Laboratory, New York
- PONTE, CHRISTINE, Regulatory Science, Dupont-Pioneer, Wilmington, Delaware
- POWELL, ANN, Plant Sciences, University of California, Davis
- PRATA, ANDRÉIA, Botânica, GaTE Laboratory, Instituto de Biociências/USP, São Paulo, Brazil
- PROVENIERS, MARCEL, Biology, Utrecht University, The Netherlands
- PRUNET, NATHANAEAL, Biological Sciences, Dartmouth College, Hanover, New Hampshire
- QI, DONG, Biology, Indiana University, Bloomington
- RAFALSKI, ANTONI JAN, Genetic Discovery, DuPont/Pioneer Hi-Bred, Wilmington, Delaware
- RAISSIG, MICHAEL, Plant Developmental Genetics, University of Zürich, Switzerland
- REGULSKI, MICHAEL, Martienssen Laboratory, Cold Spring Harbor Laboratory, New York
- REN, JIE, Delbrück, Cold Spring Harbor Laboratory, New York
- RICHARDS, ERIC, Boyce Thompson Institute for Plant Research, Ithaca, New York
- RICIGLIANO, VINCENT, Biology, St. Johns University, Queens, New York
- ROITSCH, THOMAS, Institute for Plant Sciences, University of Graz, Austria
- ROSAS, ULISES, Center for Genomics and Systems Biology, New York University, New York
- ROWE, MATTHEW, Biology, Stanford University, California
- ROWLAND, OWEN, Biology, Carleton University, Ottawa, Ontario, Canada
- SAKAI, HIROAKI, Agrogenomics Research Center, National Institute of Agrobiological Sciences, Tsukuba, Japan
- SASAKI, SHU, Graduate School of Life Science, Hokkaido University, Sapporo, Japan
- SCANLON, MICHAEL, Plant Biology, Cornell University, Ithaca, New York
- SCHATZ, MICHAEL, Center for Bioinformatics & Computational Biology, Cold Spring Harbor Laboratory, New York
- SCHMITZ, GREGOR, IEB, University Münster, Germany
- SCHNABLE, PATRICK, Plant Genomics, Iowa State University, Ames
- SCHROEDER, JULIAN, Biology, University of California, San Diego, La Jolla

- SCHUURINK, ROBERT, Plant Physiology, University of Amsterdam, The Netherlands
- SETTLES, A. MARK, Horticultural Sciences, University of Florida, Gainesville
- SEVER, RICHARD, Cold Spring Harbor Laboratory Press, Woodbury, New York
- SHAMIMUZZAMAN, MD, Crop Sciences, University of Illinois, Urbana
- SHEEN, JEN, Molecular Biology/Genetics, Massachusetts General Hospital, Boston
- SHEN, YUWEI, Plant Genetics, DNA LandMarks Inc, Saint-Jean-sur-Richelieu, Quebec, Canada
- SHIPPEN, DOROTHY, Biochemistry and Biophysics, Texas A&M University, College Station
- SHYU, CHRISTINE, Plant Research Laboratories, Michigan State University, East Lansing
- SILVER, PAMELA, Systems Biology, Harvard Medical School, Boston, Massachusetts
- SIMOROWSKI, JOSEPH, Delbrück, Cold Spring Harbor Laboratory, New York
- SINGH, DHARMENDRA, Boyce Thompson Institute, Ithaca, New York
- SINHA, NEELIMA, Plant Biology, University of California, Davis
- SKYLAR, ANNA, Molecular and Computational Biology, University of Southern California, Los Angeles
- SOHRABI, REZA, Biological Sciences, Virginia Polytechnic Institute and State University, Blacksburg
- SONIYA, E., Plant Molecular Biology, Rajiv Gandhi Centre for Biotechnology, Trivandrum, Kerala, India
- SPARKS, ERIN, Biology, Duke University, Durham, North Carolina
- SRINIVASAN, CHINNATHAMBI, Genetic Improvement, U.S. Department of Agriculture ARS-AFRS, Kearneysville, West Virginia
- STASKAWICZ, BRIAN, Plant Biology, University of California, Berkeley
- STEINBRENNER, ADAM, Plant and Microbial Biology, University of California, Berkeley
- STEWART, DAVID, Meetings and Courses Program, Cold Spring Harbor Laboratory, New York
- STILLMAN, BRUCE, Office of the President, Cold Spring Harbor Laboratory, New York
- SUDKAMP, MITCHELL, The Genome Analysis Center, Monsanto, St. Louis, Missouri
- SUGAWARA, KYOKO, Agricultural and Environmental Biology, University of Tokyo, Bunkyo-ku, Yayoi, Japan
- SURPIN, MARCI, Plant Sciences, Valent BioSciences, Long Grove, Illinois
- SUSSMAN, HILLARY, Cold Spring Harbor Laboratory Press, Genome Research, Woodbury, New York
- SZITTYA, GYORGY, Plant Biotechnology, Agricultural Biotechnology Center, Godollo, Hungary
- TAO, SIBO, School of Life Sciences, Tsinghua University, Beijing, China
- TAUSTA, LORI, MCDB, Yale University, New Haven, Connecticut
- THOMAS, BRIAN, School of Life Sciences, University of Warwick, Coventry, United Kingdom
- TIMMERMANS, MARIA, Delbrück, Cold Spring Harbor Laboratory, New York
- TINGEY, SCOTT, Genetic Discovery, DuPont Agricultural Biotechnology, Wilmington, Delaware
- TO, TAIKO, Agricultural Genetics, National Institute of Genetics, Mishima, Japan
- TORII, KEIKO, Biology, University of Washington, Seattle
- TOUCHMAN, JEFF, Molecular Breeding, Monsanto, Woodland, California
- TSUKAHARA, SAYURI, Integrated Genetics, National Institute of Genetics, Mishima, Japan
- UNDERWOOD, CHARLES, Biological Science, Cold Spring Harbor Laboratory, New York
- VALLIYODAN, BABU, Division of Plant Science, University of Missouri, Columbia
- VAN EX, FREDERIC, Martienssen Laboratory, Cold Spring Harbor Laboratory, New York
- VAN LIJSEBETENS, MIEKE, Plant Systems Biology, VIB Ghent University, Gent, Belgium
- VARALLYAY, EVA, Plant Biotechnology Institute, Agricultural Biotechnology Center, Godollo, Hungary
- VAUTIER, MARINE, Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, Stn. Sainte-Foy, Quebec
- VEIT, BRUCE, Forage Biotechnology, AgResearch, Palmerston North, New Zealand
- VI, SON, Plant Biology, Cold Spring Harbor Laboratory, New York
- VIELLE-CALZADA, JEAN-PHILIPPE, Department of Plant Genetic Engineering, National Laboratory of Genomics for Biodiversity, Irapuato, Guanajuato, Mexico
- VIERSTRA, RICHARD, Genetics, University of Wisconsin, Madison
- VINCENTZ, MICHEL, Biologia Vegetal, University of Campinas (UNICAMP) Institut of Biolo, Campinas, São Paulo, Brazil
- VOINNET, OLIVIER, Biology, Institut de Biologie Moleculaire des Plantes, Zurich, Switzerland
- VOLLBRECHT, ERIK, Genetics, Development and Cell Biology, Iowa State University, Ames
- WAN, JINRONG, Plant Sciences, University of Missouri, Columbia
- WANG, WANPENG, Plant Science and Landscape Architecture, University of Maryland, College Park
- WANG, WEI, Biology, Duke University, Durham, North Carolina
- WARE, DOREEN, Genomics, USDA ARS, Cold Spring Harbor Laboratory, New York
- WEI, SHARON, Ware Laboratory, Cold Spring Harbor Laboratory, New York
- WENG, JING-KE, The Jack H. Skirball Center for Chemical Biology, HHMI/The Salk Institute for Biological Studies, La Jolla, California
- WENGIER, DIEGO, Biology, HHMI/Stanford University, California
- WILLIAMS, JASON, DNA Learning Center, Cold Spring Harbor Laboratory, New York
- WIMALANATHAN, KOKULAPALAN, Bioinformatics and Computational Biology, Iowa State University, Ames
- WU, RUI, Plant Biology, Carnegie Institution for Science, Stanford, California
- WU, XUELIN, Molecular and Computational Biology, University of Southern California, Los Angeles
- XIE, JIAHUA, Pharmaceutical Sciences, North Carolina Central University, Durham
- YAMAMOTO, YOSHIHARU, Faculty of Applied Biological Science, Gifu University, Japan
- YAN, SHUNPING, Biology, Duke University, Durham, North Carolina
- YANG, FANG, Plant Biology, Cold Spring Harbor Laboratory, New York
- YAO, JAIN, Plant Research Laboratory, Michigan State University, East Lansing
- YOSHIDA, AKIKO, Graduate School of Agricultural and Life Sciences, The University of Tokyo, Japan
- ZAMIR, DANIEL, Agriculture, The Hebrew University of Jerusalem, Rehovot, Israel
- ZANETTI, MARIA, Instituto de Biotecnología y Biología Molecular, Universidad Nacional de Mar del Plata and CONICET, La Plata, Argentina
- ZEMACH, ASSAF, Plant and Microbiology, University of California, Berkeley
- ZENG, WEIQING, Pioneer Regulatory Science, DuPont/Pioneer, Wilmington, Delaware
- ZHANG, LIFANG, Ware Laboratory, Cold Spring Harbor Laboratory, New York
- ZHANG, YU, Plant and Microbial Biology/PGEC, University of California, Berkeley, Albany
- ZHANG, ZHIMING, Ware Laboratory, Cold Spring Harbor Laboratory, New York
- ZHAO, RONGMIN, Biological Sciences, University of Toronto, Canada
- ZHONG, SHANGWEI, MCDB, Peking Yale Joint Center, New Haven, Connecticut
- ZHOU, CHUANEN, Forage Improvement Division, The Samuel Roberts Noble Foundation, Ardmore, Oklahoma
- ZHU, JIAN-KANG, Horticulture and Landscape Architecture, Purdue University, West Lafayette, Indiana
- ZILBERMAN, DANIEL, MCD Biology, University of California, Berkeley

First row: C. Pikaard, S. Jacobson, B. Stillman, and M. Settles; N. Sinha, D. Bergmann, M. Timmermans

Second row: Wine and cheese party

Third row: L. Bulla; participants with caricature; P. Benfey, U. Rosas

Fourth row: A. Hieno, S. Inagaki; V. Colot, R. Doerge; L. Zhang

First row: S. Howell; U. Grossniklaus, A. Gann; Z. Lippman, J. Feijo; H. Sussman

Second row: T. Brutnell, E. Vollbrecht; A. Prata, M. Bottino

Third row: S. Hake, B. Veit; P. Jenik; W. Frommer, P. Kjellbom

Fourth row: X.-W. Deng; P. Silver, J. Jones; D. Lieberman

Fifth row: C. Kotakis; J. Doebley; relaxing on Airlie's lawn

First row: T. Roitsch, S. Kumari; J. P. Vielle-Calzada, J. Paszkowski; D. Baulcomb, S. Kamoun

Second row: Symposium picnic; poster—movie night

Third row: B. McClintock exhibit; K. Liberatore explaining poster; A. Husbands

Fourth row: O. Voinnet, F. J. Berger; G. Bilsborough, J. Bailey Serres; R. Sever and audience

First row: X. Chen, E. Marcus; D. Zamir, D. Ware; D. Shippen, E. Roberts

Second row: Symposium picnic; dinner at Blackford

Third row: J. Chory; J. Dangel Q&A; C. Zepeda Mendoza

Fourth row: J. Lohman; P. Schnable, G. Jander, R. Amasino; Y. Plavskin, J. Ecker; A. Prata, V. Pakaluk

First row: J. Barber; S. Tigney, R. Martienssen; G. Galiba

Second row: Delbruck drinks; X. Dong, M. Gehring

Third row: V. Colot, D. Stewart; F. J. Berger; J. Inglis, D. Goto

Fourth row: C. Kuhlemeier; on the beach; S. Poethig

Fifth row: M. Lodha, S. Harmer; K. Creasey, N. Geldner

*First row: M. Estelle, S. Hake; O. Leyser, D. Jackson
Second row: C. Pikaard, M. Matzke; M. Regulski, J. Rafalski
Third row: K. Jiang, J. Maloof; C. Furnes, S. Perochon
Fourth row: Watching Symposium talks under the tent*

Foreword

The Cold Spring Harbor Symposia on Quantitative Biology bring together scientists from all over the world to present and evaluate new data and ideas in rapidly moving areas of biological research. Each year, a topic is chosen that appears to be at a stage where general and intensive scrutiny and review are needed. Criteria for selection of topics are numerous, but they include the rate of progress in a given field, how recent research is highlighting connections between fundamental biological mechanisms, and the potential applications of the new discoveries to human health and society. Cold Spring Harbor Laboratory selected the theme of The Biology of Plants for the historic 77th Symposium in the series.

Plants are integral to human well being, and many species have been domesticated for more than 10,000 years. Evidence of plant scientific investigation and classification can be found in ancient texts from cultures around the world (Chinese, Indian, Greco-Roman, Muslim, etc.), whereas early modern botany can be traced to the late 15th and early 16th centuries in Europe. During the past several decades, plant biology has been revolutionized first by molecular biology and then by the genomic era. The model organism *Arabidopsis thaliana* has proved to be an invaluable tool for investigation into fundamental processes in plant biology, many of which share commonalities with animal biology. Plant-specific processes from reproduction to immunity and second messengers have also yielded to extensive investigation. With the genomes of more than 30 plant species now available and many more planned in the near future, the impact on our understanding of plant evolution and biology continues to grow. Our increased ability to engineer plant species to a variety of ends may provide novel solutions to ensure adequate and reliable food production and renewable energy even as climate change impacts our environment.

The decision to focus the 2012 Symposium on plant science reflected the enormous research progress achieved in recent years and was intended to provide a broad synthesis of the current state of the field, setting the stage for future discoveries and application. This is the first Symposium in this historic series that focused exclusively on the botanical sciences. The Symposium spanned a broad range of areas of investigation including genetics, biochemistry, molecular and cell biology, developmental biology, physiology, and population/evolution studies at levels ranging from the single cell to the entire organism and from single genes to genomes; plant-specific processes and pathways featured broadly throughout the meeting. Effort was made to balance fundamental biological discoveries with applications relevant to societal well being including improved crops, fuel, and habitat. In arranging this Symposium, the organizers were dependent on the guidance of a broad cadre of advisors including Drs. Phil Benfey, JoAnne Chory, Nam-Hai Chua, Jeff Dangl, Joe Ecker, and Chris Somerville. Opening night speakers included Sarah Hake, Craig Pikaard, Joanne Chory, and Jeff Dangl. Rob Martienssen delivered a compelling Dorcas Cummings Lecture on “Send in the Clones” to Laboratory friends, neighbors, and Symposium participants in advance of the annual dinner parties.

This Symposium was attended by almost 320 scientists from more than 20 countries, and the program included 65 invited presentations and 169 poster presentations. To disseminate the latest results and discussions of the Symposium to a wider audience, attendees were able to share many of the Symposium talks with their colleagues who were unable to attend using the Leading Strand video archive, while interviews by Gemma Bilsborough, Inês Chen, Kate Creasey, Emilie Marcus, Richard Sever, and Jan Witkowski with leading experts in the field were arranged during the Symposium and distributed as free video from the Cold Spring Harbor Symposium interviews website.

We thank Val Pakaluk, Mary Smith, and Ed Campodonico and his staff, in the Meetings & Courses Program, for their assistance in organizing and running the Symposium, and John Inglis and his staff at Cold Spring Harbor Laboratory Press, particularly Rena Springer, for publishing the printed and online versions of the Symposium proceedings. Photographer Connie Brukin captured candid snapshots throughout the meeting.

Funds to support this meeting were obtained from the National Science Foundation, the Gordon & Betty Moore Foundation and the Gatsby Charitable Foundation. Financial support from the corporate sponsors of our meetings program is essential for these Symposia to remain a success and we are most grateful for their continued support.

Bruce Stillman
Terri Grodzicker
Rob Martienssen
David Stewart

Sponsors

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

Corporate Benefactor

Astellas OSI Oncology

Corporate Sponsors

Agilent Technologies

Bristol-Myers Squibb Company

Genentech, Inc.

GlaxoSmithKline

Life Technologies (Invitrogen & Applied Biosystems)

New England BioLabs, Inc.

Sanofi US

Plant Corporate Associates

Monsanto Company

Pioneer Hi-Bred International, Inc.

**COLD SPRING HARBOR SYMPOSIA
ON QUANTITATIVE BIOLOGY
VOLUME LXXVII**

Cold Spring Harbor Symposia on Quantitative Biology

Front Matter

Cold Spring Harb Symp Quant Biol 2012 77: i-xviii
Access the most recent version at doi:[10.1101/sqb.2012.77.FM](https://doi.org/10.1101/sqb.2012.77.FM)

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>