# COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY

# VOLUME LXXVII

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# COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY

## VOLUME LXXVII

# The Biology of Plants

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

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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*

*COLD SPRING HARBOR SYMPOSIA ON QUANTITATIVE BIOLOGY*
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REGINALD G. HARRIS
*Director of the Biological Laboratory 1924 to 1936*
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***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).



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# 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 Bioquimica Medica, 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 Superieure, 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
DANGL, 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, XINNIAN, 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
FEIJO, JOSE, Institute 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 Catolica de Chile, Santiago
HACHEZ, CHARLES, Institut des Sciences de la Vie, Universite 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
IURIF, VANESSA, Instituto de Bioquimica 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, MICHAL, Plant Molecular Physiology, Institute of Bioorganic Chemistry, PAS, Poznan, 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 Ileia, 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

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
Leyser, 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, Varda, 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
Martienssen, 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, Nathanael, 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, MARJA, 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 LIJSEBETTENS, 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, MARÍA, 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. Doebbley; relaxing on Airslie'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. Dangl 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
*Firth 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

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