

CHEMICAL HERITAGE FOUNDATION

BRADLEY B. OLWIN

The Pew Scholars Program in the Biomedical Sciences

Transcript of an Interview
Conducted by

Steven J. Novak

at

Purdue University
West Lafayette, Indiana

on

30 November and 1, 2 December 1994

From the Original Collection of the University of California, Los Angeles

ACKNOWLEDGEMENT

This oral history is part of a series supported by a grant from the Pew Charitable Trusts based on the Pew Scholars Program in the Biomedical Sciences. This collection is an important resource for the history of biomedicine, recording the life and careers of young, distinguished biomedical scientists and of the Pew Scholars Program in the Biomedical Sciences Advisory Committee members.

This oral history was completed under the auspices of the Oral History Project, University of California, Los Angeles (Copyright © 1998, The Regents of the University of California) and is made possible through the generosity of



**From the original collection at the Center for
Oral History Research, UCLA Library, UCLA.**

The following oral history, originally processed at the UCLA Center for Oral History Research, has been reformatted by the Chemical Heritage Foundation. The process involved reformatting the front matter, adding a new abstract, replacing the table of contents, and replacing the index. The paragraph spacing and font of the body of the transcript were altered to conform to the standards of the Oral History Program at the Chemical Heritage Foundation. The text of the oral history remains unaltered; any inadvertent spelling or factual errors in the original manuscript have not been modified. The reformatted version and digital copies of the interview recordings are housed at the Othmer Library, Chemical Heritage Foundation. The original version and research materials remain at the Darling Library, University of California, Los Angeles and at the Bancroft Library, University of California, Berkeley.

REFORMATTING:

Marnie Berkowitz, Consultant to the Chemical Heritage Foundation. B.A., Classical Languages and Literatures, University of Minnesota; Ford Foundation Fellowship, Classical Languages and Literatures, University of Chicago.

David J. Caruso, Program Manager, Oral History, Chemical Heritage Foundation. B.A., History of Science, Medicine, and Technology, Johns Hopkins University; PhD., Science and Technology Studies, Cornell University.

UNIVERSITY OF CALIFORNIA, LOS ANGELES

Oral History Interview Agreement No. R941208

This Interview Agreement is made and entered into this 21st day of December, 1994 by and between THE REGENTS OF THE UNIVERSITY OF CALIFORNIA, a California corporation, on behalf of the Oral History Program at the UCLA campus, hereinafter called "University," and BRADLEY B. OLWIN having an address at Biochemistry Department, 1153 Biochemistry Building, Purdue University, West Lafayette, Indiana, 47907-1153, hereinafter called "Interviewee."

Interviewee agrees to participate in a series of University-conducted tape-recorded interviews, commencing on or about November 30, 1994, and tentatively entitled "Interview with Bradley B. Olwin". This Agreement relates to any and all materials originating from the interviews, namely the tape recordings of the interviews and a written manuscript prepared from the tapes, hereinafter collectively called "the Work."

In consideration of the mutual covenants, conditions, and terms set forth below, the parties hereto hereby agree as follows:

1. Interviewee irrevocably assigns to University all his copyright, title and interest in and to the Work. This assignment applies to University, its successors, and assigns, for and during the existence of the copyright and all renewals and extensions thereof.
2. By virtue of this assignment, University will have the right to use the Work for any research, educational, or other purpose that University may deem appropriate.
3. Interviewee acknowledges that he will receive no remuneration or compensation for his participation in the interviews or for the rights assigned hereunder.
4. Interviewee will receive from University, free of charge, one bound copy of the typewritten manuscript of the interviews.
5. To insure against substantive error or misquotation, Interviewee will have the right to review the manuscript before it is put into final form. University therefore will send Interviewee a copy of the edited transcript for review and comment. Interviewee will return transcript and comments to University within 30 days of receipt of the transcript. In the event that Interviewee does not respond within 30 days, University will assume that Interviewee has given full approval of the transcript.

6. All notices and other official correspondence concerning this Agreement will be sent to the following:

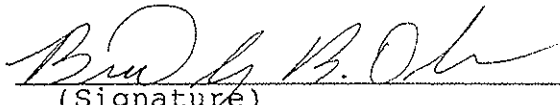
If to University: Office of Intellectual Property Administration
University of California, Los Angeles
405 Hilgard Avenue
Los Angeles, California 90024-1406

Attention: Ms. Carli V. Rogers
Copyright Officer

If to Interviewee: Bradley B. Olwin
Biochemistry Department
1153 Biochemistry Building
Purdue University
West Lafayette, IN 47907-1153

University and Interviewee have executed this Agreement on the date first written above.

INTERVIEWEE


(Signature)

Bradley B. Olwin
(Typed Name)

Biochemistry Department

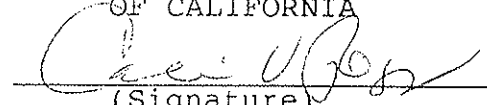
1153 Biochemistry Building

Purdue University
(Address)

West Lafayette, IN 47907-115

Date 11/30/94

THE REGENTS OF THE UNIVERSITY
OF CALIFORNIA


(Signature)

Carli V. Rogers
(Typed Name)

Copyright Officer
(Title)

405 Hilgard Avenue
(Address)

Los Angeles, CA 90095-1406

Date December 21, 1994

This interview has been designated as **Free Access**.

One may view, quote from, cite, or reproduce the oral history with the permission of CHF.

Please note: Users citing this interview for purposes of publication are obliged under the terms of the Chemical Heritage Foundation Oral History Program to credit CHF using the format below:

Bradley B. Olwin, interview by Steven J. Novak at Purdue University, West Lafayette, Indiana, 30 November and 1, 2 December 1994 (Philadelphia: Chemical Heritage Foundation, Oral History Transcript # 0488).



Chemical Heritage Foundation
Oral History Program
315 Chestnut Street
Philadelphia, Pennsylvania 19106



The Chemical Heritage Foundation (CHF) serves the community of the chemical and molecular sciences, and the wider public, by treasuring the past, educating the present, and inspiring the future. CHF maintains a world-class collection of materials that document the history and heritage of the chemical and molecular sciences, technologies, and industries; encourages research in CHF collections; and carries out a program of outreach and interpretation in order to advance an understanding of the role of the chemical and molecular sciences, technologies, and industries in shaping society.

BRADLEY B. OLWIN

1957 Born in Saint Paul, Minnesota on 15 January

Education

1979 B.A., University of California, San Diego
1984 Ph.D., University of Washington

Research Appointments

1984-1985 Postdoctoral Fellow, University of California, San Francisco
1985-1987 Postdoctoral Fellow, University of Washington

Professional Experience

1988-1993 University of Wisconsin-Madison
Assistant Professor
1993 Associate Professor

1993-present Purdue University
Walther Associate Professor of Biochemistry

Honors

1983 Achievement Reward for College Scientists
1989-1993 Shaw Scholar
1990-1994 Pew Scholar in the Biomedical Sciences
1991 Pound Research Award, College of Agriculture and Life Sciences,
University of Wisconsin-Madison

Selected Publications

Olwin, B.B. et al., 1982. Interaction of a fluorescent N-dansylaziridine derivative of troponin I with calmodulin in the absence of calcium. *Biochemistry* 21:5669-75.
Olwin, B.B. et al., 1983. Immunoaffinity purification and characterization of 5-iodo-acetyl-amino-ethyl-amino-1-naphthalene sulfonic acid-derivatized calmodulin. *Biochemistry* 22:5390-95.

- Olwin, B.B. et al., 1984. Quantitation of energy coupling between Ca^{2+} , calmodulin, skeletal muscle myosin light chain kinase and kinase substrates. *Journal of Biological Chemistry* 259:10949-55.
- Olwin, B.B. and D.R. Storm, 1985. Calcium binding to complexes of calmodulin and calmodulin binding proteins. *Biochemistry* 24:8081-6.
- Olwin, B.B. and Z.W. Hall, 1985. Developmental accumulation of laminin in the extracellular matrix of a mouse muscle cell line. *Developmental Biology* 112:359-67.
- Olwin, B.B. and S.D. Hauschka, 1986. Identification of the fibroblast growth factor receptor of Swiss 3T3 cells and mouse skeletal muscle myoblasts. *Biochemistry* 25:3487-92.
- Olwin, B.B. and S.D. Hauschka, 1988. Cell surface fibroblast growth factor and epidermal growth factor receptors are permanently lost during skeletal muscle terminal differentiation in culture. *Journal of Cell Biology* 107:761-69.
- Olwin, B.B. and S.D. Hauschka, 1989. Cell type and tissue distribution of the FGF receptor. *Journal of Cellular Biochemistry* 39:443-54.
- Burrus, L.B. and B.B. Olwin, 1989. Isolation of a receptor for acidic and basic fibroblast growth factor from embryonic chick. *Journal of Biological Chemistry* 264:18647-53.
- Olwin, B.B. and S.D. Hauschka, 1990. Fibroblast growth factor receptor levels decrease during chick embryogenesis. *Journal of Cell Biology* 110:503-9.

ABSTRACT

Bradley B. Olwin was born in St. Paul, Minnesota, but his family moved to Los Alamos, New Mexico, when Olwin was an infant. There his father was an engineer who worked on the Poseidon Missile warhead and on nuclear testing at the test sites in Nevada; his mother was a housewife. Olwin has one younger brother, who now works as an engineer for the Boeing Company in Seattle, Washington. Olwin's family was a close one, engaging in outdoor weekend activities like skiing, water skiing, hiking, camping, backpacking. He still travels to the Cascade Mountains to climb, camp, and backpack. In high school he loved science but also studied Russian literature. Olwin matriculated at University of California at San Diego because he wanted to be an oceanographer; but he soon switched his major to chemistry, which he loved. He also kept up his Russian during college. While still an undergraduate Olwin worked in Stuart Brody's lab and in Susan Taylor's lab. Olwin applied and was accepted to the University of Washington, where he entered the pharmacology department. After rotations in Joseph A. Beavo's and Daniel R. Storm's labs, he joined the Storm lab. He found a mentor in his lab postdoc, David C. LaPorte; there he used anisotropy to study calmodulin-binding interactions. In his third year of graduate school Olwin and his first wife, whom he had married before he left San Diego, were divorced. Subsequently, Olwin met and married Jennifer Martin, who was also a student in pharmacology at the University of Washington. They have two children. Olwin accepted a postdoc at University of California at San Francisco in Zach Hall's lab, but because Jennifer was not able to transfer to San Francisco Olwin left Hall's lab after just one year and went to Stephen Hauschka's lab at University of Washington, where he stayed for three years. From there he accepted an assistant professorship at the University of Wisconsin. Because his wife could not get a job there eventually Olwin decided to accept a professorship at Purdue. There Jennifer also was offered a position, and there they remain today. Olwin continues to work on the effects of fibroblast growth factor (FGF) on cell differentiation and regulation, cell de-differentiation, and signaling.

UCLA INTERVIEW HISTORY

INTERVIEWER:

Steven J. Novak, Senior Editor, UCLA Oral History Program. B.A., History, University of Colorado; Ph.D., History, University of California, Berkeley; M.B.A., UCLA Graduate School of Management.

TIME AND SETTING OF INTERVIEW:

Place: Tapes I-IV, Olwin's office, Purdue University; Tapes V-VI, Olwin's home, West Lafayette, Indiana.

Dates, length of sessions: November 30, 1994 (107 minutes); December 1, 1994 (84); December 2, 1994 (42); December 3, 1994 (91).

Total number of recorded hours: 5.5

Persons present during interview: Olwin and Novak.

CONDUCT OF INTERVIEW:

This interview is one in a series with Pew scholars in the biomedical sciences conducted by the UCLA Oral History Program in conjunction with the Pew Charitable Trusts's Pew Scholars in the Biomedical Sciences Oral History and Archives Project. The Project has been designed to document the backgrounds, education, and research of biomedical scientists awarded four-year Pew scholarships since 1988.

To provide an overall framework for Project interviews, the director of the UCLA Oral History Program and three UCLA faculty consultants developed a topic outline. In preparing for this interview, Novak held a preinterview telephone conversation with Olwin to obtain written background information (curriculum vitae, copies of published articles, etc.) and to agree on an interviewing schedule. He also reviewed prior Pew scholars' interviews and the documentation in Olwin's file at the Pew Scholars Program office in San Francisco, including his proposal application, letters of recommendation, and reviews by Pew Scholars Program national advisory committee members.

For technical background, Novak consulted J.D. Watson et al., *Molecular Biology of the Gene*. 4th ed. Menlo Park, CA: Benjamin/Cummings, 1987 and Bruce Alberts et al., *Molecular Biology of the Cell*. 3d ed. New York: Garland, 1994.

The interview is organized chronologically, beginning with Olwin's childhood in Los Alamos, New Mexico, and continuing through his education at the University of California, San Diego, and the University of Washington and the establishment of his labs at the University of Wisconsin-Madison and Purdue University. Major topics discussed include his research on the effect of fibroblast growth factor on cell regulation, differentiation, and signaling; the importance of basic research; science funding; and the problems facing women and two-career couples in the sciences.

ORIGINAL EDITING:

Kristian London, editorial assistant, edited the interview. He checked the verbatim transcript of the interview against the original tape recordings, edited for punctuation, paragraphing, and spelling, and verified proper names. Words and phrases inserted by the editor have been bracketed.

Olwin did not review the transcript and therefore some proper names have not been verified.

Jane Collings, editor, prepared the table of contents and interview history. London assembled the biographical summary. JinAh Lee, editorial assistant, compiled the index.

TABLE OF CONTENTS

Family Background	1
Father's position at Los Alamos National Laboratories. Joys of outdoor recreation. Interest in science in high school. Competitive nature of contemporary science.	
Undergraduate Years	10
Classes at the University of California, San Diego (UCSD). Work in the Stuart Brody lab and the Susan S. Taylor lab. Olwin's poor GRE scores. Interest in receptors and cellular communication. Inspiring professors at UCSD. Publications from his lab work.	
Graduate Years	19
Rotations in the Joseph A. Beavo's, Daniel R. Storm's, and G. Stanley McKnight labs. Joins the Storm lab. Finds a mentor in lab postdoc David C. LaPorte. Uses fluorescence anisotropy to study calmodulin-binding interactions. Olwin's first marriage and his divorce. Outdoor recreation in the Seattle area. Second wife, Jennifer M. Martin.	
Postdoc at UCSF	34
Begins postdoctoral work on muscle in the Zach W. Hall lab at University of California, San Francisco (UCSF). Unhappy at treatment of his wife, Olwin leaves after one year	
Postdoc at University of Washington	43
Begins research on fibroblast growth factor (FGF) in the Stephen D. Hauschka lab. FGF's role in cell growth and differentiation. Disproving the hypothesis that differentiated muscle cells' lack of response to FGF is caused by receptor loss. Why the cysteine-rich FGF receptor may be important--Helpful collaborations while a postdoc in the Hauschka lab. Applies for principal investigator positions.	
Faculty Position at University of Wisconsin	56
Olwin establishes his lab at the University of Wisconsin-Madison. Jennifer M. Martin's job search. Collaborative work with Alan C. Rapraeger. Finds that heparan sulfate may control FGF binding to the receptor. Collaboration with John F. Fallon on FGF as a limb outgrowth factor. Faculty attrition at the University of Wisconsin.	
Faculty position at Purdue	60
Both Olwin and his wife offered faculty positions at Purdue. Research on FGF and cell de-differentiation. More on the cysteine-rich receptor. Technical problems in the lab. Current projects in Olwin's lab--His work's relationship to the larger FGF and muscle fields--Clinical applications of his work. University	

teaching and administrative duties. Funding. Politics of publishing. Balancing home life and work.

Index

109

INDEX

A

Abelson, John N., 21
acetylcholine, 21, 41, 47
acquired immune deficiency syndrome, 94
adenosine monophosphate, 16, 19, 20, 28
adenosine triphosphate, 13, 14
adenylate cyclase, 19, 26
AIDS. *See* acquired immune deficiency syndrome
Albuquerque, New Mexico, 4, 5
AMP. *See* adenosine monophosphate
anisotropy, 25, 28
apical ectodermal ridge, 65, 68
Arthur, Kirstin, 49, 74, 82
Asai, David J., 71

B

Baltimore, Maryland, 55
Barritault, Denis, 52
Beavo, Joseph A., 19, 20, 23
Bieber, Allan J., 71
Bishop, David, 38
Bjorkman, Pamela J., 9, 107
Boeing Company, 3
Bothwell, Mark, 38
Bourne, Henry R., 41
Bowen-Pope, Daniel F., 53
Brody, Stuart, 15
Burrus, Laura B., 68

C

calcineurin, 31
calmodulin, 25, 27, 28, 29, 30, 31, 39, 40, 47, 53
Cascade Mountains, 7
Catterall, William A., 20
Chapel Hill, North Carolina, 54
Charbonneau, Harry, 53, 71
Chen, Dr., 27
Chicago, Illinois, 104

chromophore, 25
Clegg, Christopher H., 48
Clegg, Dennis O., 41
Cleveland, Don W., 55
Coleman, Kelley A., 29, 30, 33, 34
Cox, Michael M., 57
Crabtree, Gerald R., 31
Crick, Francis H.C., 21
cyclophilins, 40
cysteine, 52, 68, 74, 83
Czech, Michael P., 94

D

Deluca, Hector F., 58, 78, 100
Deluca, Marlene A., 36
DNA, 46, 50, 67, 87, 94
Drosophila, 52, 75
Duchenne's muscular dystrophy, 85
dystrophin, 85

E

Edmonton, Canada, 55
Ellington, Andrew D., 72, 108

F

Fallon, John F., 64, 65, 66
Fedorov, Yuri, 14, 69
FGFs, *See* fibroblast growth factor
fibroblast growth factor, 42, 43, 44, 45, 46, 49, 50, 52, 62, 63, 65, 66, 74, 75, 79, 80, 81, 82, 83, 84, 86, 103, 107, 108
Fiji, 82

G

gastrin cholestecystic kinin, 83
Gilman, Alfred G., 26
Golgi, 83
G-protein, 26, 83
Graduate Record Exam, 17, 18, 19, 37
GRE. *See* Graduate Record Exam
Greenlee, William F., 61

Greider, Carol W., 94

H

Hall, Zach, 40, 41, 42, 43, 45, 47, 60
Hannon, Kevin M., 49, 69, 79, 82, 83, 98
Hansen Life Sciences Research Building, 61
Harvard University, 17, 31, 34
Hauschka, Stephen D., 38, 41, 42, 43, 44, 45, 51, 52, 54, 55, 56, 58, 60, 80, 81, 108
Hayes, Colleen E., 100
Hector, 58, 59, 78
Heideman, Warren, 26, 33
heparan sulfate, 63
Herschman, Harvey R., 59, 67, 76, 95
high performance liquid chromatography, 29
Hoffmann, F. Michael, 75
Hood, Leroy E., 105
Howard Hughes Medical Institute, 19, 98, 105, 106
Howard, Jonathon, 86
HPLC. *See* high performance liquid chromatography
Hunter, Anthony, 98
hygromycin, 73

I

Indiana, 6, 8, 23, 61, 72
Indiana University, 61, 72
IU. *See* Indiana University

J

Jefferson, President Thomas, 87
Johns Hopkins University, 54, 55
Jones, Nathan, 82, 98

K

Kimble, Judith, 57
Knauer, Daniel J., 54
Konieczny, Stephen F., 59, 60, 70
Konigsberg, Irwin R., 44
Koshland Jr., Daniel E., 32
Krebs, Edwin G., 19, 20, 23, 56, 105
Kudla, Arthur J., 49, 82, 98

Kyte, Jack E., 18

L

lactate dehydrogenase, 16
laminin, 41
Lanahan, Anthony "Ty", 38
Lane, Daniel M., 55
LaPorte, David C., 24, 25, 26, 27, 30
Lefkowitz, Robert J., 26
Liang, P., 74
Lim, Robert W., 51
Lincoln, Nebraska, 2
Lockheed Aircraft Corporation, 2
López, Alric, 66
Los Alamos National Laboratories, 1
Los Alamos, New Mexico, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Los Angeles, California, 6

M

Madison, Wisconsin, 10, 13, 60, 68, 69, 78
Martin, Jennifer M. (wife), 8, 34, 38, 40, 41, 42, 47, 56, 57, 58, 59, 60, 71, 78, 79, 92, 99, 100
Martins, Timothy J., 29, 30
McKnight, G. Stanley, 23
McMahon, Andy, 68
MDA. *See* Muscular Dystrophy Association
Mensa, 34
micromanipulator, 74
Minnesota, 2, 4
MM14, 43, 77
Muir College, 12, 13
Muscular Dystrophy Association, 42, 43
myoblasts, 48, 85
myosin light chain kinase, 28, 30
myotubes, 41, 48, 85

N

Nathanson, Neal, 47
National Institutes of Health, 32, 34, 57, 64, 71, 72, 75, 90, 93, 94, 105, 107
Neurospora, 15
Nevada, 5

NIH. *See* National Institutes of Health
Nobel Prize, 26, 64, 94, 106
Northern blot, 49

O

Ohio State University, 69
Olwin, Anthony "Ty" Martin (son), 8
Olwin, Catherine Erskine (paternal grandmother), 4
Olwin, Edwin (paternal grandfather), 4
Olwin, Katherine E. (daughter), 8
Olwin, Marilyn Suhr (mother), 1
Olwin, Richard B. (father), 1
Olwin, Stephen R. (brother), 3

P

Palmiter, Richard D., 23
Pardee, Arthur B., 74
PCR. *See* polymerase chain reaction
PDGF. *See* platelet-derived growth factor
Peace Corps, 82
Pew Scholars in the Biomedical Sciences, 9, 64, 70, 71, 72, 74, 79, 86, 94, 98, 102, 105, 107
pharmacology, 17, 20, 21, 22, 23, 34, 47, 59, 61
phosphodiesterase, 30
Piwnica-Worms, Helen M., 98
platelet-derived growth factor, 81, 82, 87
Pollard, Thomas D., 54, 55
polyacrylamide, 50
polymerase chain reaction, 22, 49, 50, 82
Poseidon missile, 5
Presidential Young Investigator Award, 72
proteoglycan, 63
Purdue University, 18, 53, 59, 60, 61, 63, 69, 70, 71, 72, 91, 95

R

Raines, Elaine W., 53
Rapid City, South Dakota, 3
Rapraeger, Alan C., 57, 63
ras MAP-kinase, 81
Rayment, Ivan, 84

Reichardt, Louis F., 41, 43, 60
retrovirus, 64, 65, 66, 67, 76
Reznikoff, William S., 58
ribonucleic acid, 48, 73, 74, 94
Riley, Bruce, 64
RNA. *See* ribonucleic acid
RNase, 49, 82
Rosenberg, Gary A., 33
Ross, Russell, 53, 80
Rothman, James E., 103

S

Saier, Milton H., 15
Saint Paul, Minnesota, 1
San Diego, California, 15, 16, 33
Sanes, Joshua R., 41
Sato, Gordon H., 21
Schreiber, Stuart L., 31
Searle scholarship, 72
Seattle, Washington, 3, 8, 23, 25, 33, 37, 40, 42, 53, 58, 62, 101
Seelex, 108
serine/threonine, 98
serum albumin, 29
Shiloh, Ben Zion, 75
silane, 80
South Dakota School of Mines and Technology, 3
Spitzer, Nicholas C., 21
Stanford University, 31
Steenbock Career Development Award, 57
Storm, Daniel R., 20, 23, 24, 25, 26, 29, 31, 34, 37, 40, 41, 45, 47, 59
Sugden, William, 58
Svoboda, Karel, 86
Szebenyi, Györgyi, 66

T

T cell, 31
Taylor, Palmer W., 21
Taylor, Susan S., 16, 19, 20, 21, 23
Temin, Howard M., 64
Tetrahymena, 94
Toscano Jr., William A., 59
troponin, 28, 30, 39

tyrosine, 52, 82, 86, 98

U

UCSD. *See* University of California at San Diego

UCSF. *See* University of California at San Francisco

University of Alberta, 55

University of California, 10

University of California at Berkeley, 10, 95

University of California at Davis, 12, 40

University of California at Irvine, 54

University of California at Los Angeles, 67

University of California at San Diego, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 33, 36

University of California at San Francisco, 34, 40, 41

University of Illinois, 25

University of Kentucky, 59

University of Minnesota, 3, 24, 59

University of New Mexico, 12

University of North Carolina, 54, 55, 70

University of Vermont, 72

University of Washington, 17, 19, 23, 37, 38, 101

University of Wisconsin, 10, 18, 55, 56, 58, 59, 62, 63, 64, 65, 68, 70, 71, 75, 95, 101

V

Vanderbilt University, 17

Vietnam, 10

W

Walther Cancer Institute, 106

Weber, Gregorio, 25, 27

Weintraub, Harold, 86

Wickens, Marvin P., 57

Williams, Lewis T. (Rusty), 75

Winter, Janet, 41

Wyoming, 7

X

Xenopus, 75

Y

Yale University, 17

Yamamoto, Keith R., 21

Z

Zhou, Zhaohui, 97

Zinn, Kai, 9, 10, 107

Zoller, Mark J., 16

β

β-galactosidase, 85