Curriculum Vitae

ALEXANDER WLODAWER, Ph.D.

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Scientific and Administrative Responsibilities:

My current position involves both scientific and administrative responsibilities. As Head of the Protein Structure Section, I direct the research of a team currently consisting of two Staff Scientists, a Biologist, a Postdoctoral Fellow, a Technician, and a Computer Systems Administrator (some of them are administratively attached to the Office of the Chief, Macromolecular Crystallography Laboratory). Although several of the team members are experienced and respected scientists in their own right, I have the ultimate responsibility for their scientific direction and progress. As Chief of the Macromolecular Crystallography Laboratory, I am in charge of three Sections (including my own). These include the Biomolecular Structure Section, under Dr. Xinhua Ji and the Synchrotron Radiation Research Section, under Dr. Zbyszek Dauter. The total annual budget of the Laboratory under my direct control is currently more than 4.5 million dollars, excluding capital equipment costs. I have also been involved in limited teaching on graduate level, through my appointment as an Adjunct Professor of Biochemistry and Molecular Biology at the George Washington University, Washington DC, and was an outside examiner on several Ph. D. theses at the University of Uppsala, Sweden, and University of Helsinki, Finland.

Scientific Accomplishments:

My career in the field of structural biology spans more than 40 years. During that time, I have been mainly involved in the development of techniques of X-ray and neutron crystallography and in the application of these methods to solving the crystal structures of biologically important molecules. The technical aspects of this work include the first protein crystallography experiments conducted on a synchrotron source, which yielded diffraction data and phasing using radiation tuned to the absorption edge of heavy atoms in protein crystals, as well as the construction of a novel neutron diffractometer utilizing a linear detector. New crystal structures solved either entirely in my laboratory or in collaboration with other crystallographers include L-asparaginase, which is used as an anticancer drug; a sweet protein, monellin; a mammalian aspartic protease, chymosin, its barley counterpart, phytepsin, its yeast counterpart, proteinase A, the latter complexed with the inhibitor IA_3, and a pepsin-fold allergen Bla g 2, by itself and complexed with

antibody fragments; novel serine-carboxyl proteases sedolisin and kumamolisin-As; N-terminal domain, substrate-recognition domain, and the proteolytic domains of the ATP-dependent proteases Lon and ClpP; a DNA 15-mer with unpaired bases; retroviral proteases from Rous sarcoma virus, human immunodeficiency virus, human T-cell leukemia virus, equine infectious anemia virus, feline immunodeficiency virus, and xenotropic murine leukemia virus-related virus (XMRV); plasmepsin I and histo-aspartic protease HAP; bacterial aspartic protease APRc; antibody complexes of a fragment of HIV-1 gp41; cytokines IL-8, IL-4, IL-10, IL-19, and a complex of interferon λ with its receptor; chemokines MCP-1 and RANTES; nerve growth factor; catalytic domains of the Rous sarcoma virus integrase and of HIV integrase; RNase H domain of the XMRV reverse transcriptase; rabbit muscle creatine kinase; RNA cyclase; cyclic nucleotide phosphdiesterase; phage M13 minor coat protein and its fusion with bacterial TolA; phage λ protein gpD; C-terminal domain of bacterial TonB; bacterial HdeA; antiviral lectins cyanovirin, griffithsin, and scytovirin, as well as their carbohydrate complexes; protease inhibitors EcTI, BbKI and CrataBL; lectin CGL; protein serine kinases Rio1 and Rio2; MA3 domain of Pdcd4; *Shigella* virulence factor VirA; a number of variants of green, red, and blue fluorescent proteins; a number of inteins. Using both X-ray and neutron diffraction, I have analyzed in detail the structures of such “standard” proteins as bovine pancreatic trypsin inhibitor, ribonuclease A, and insulin in order to study the principles of structure-function relationship in well-known systems. I have published a number of papers dealing with the comparison and analysis of protein structures and with novel methods of structure determination, as well as several major reviews. The total number of publications coauthored by me exceeds 385 and my Hirsch index is 70.

Administrative Accomplishments:

In 1987, I created the Macromolecular Structure Laboratory in the Basic Research Program, (BRP), ABL/NCI-FCRDC. Originally called the Crystallography Laboratory, it was primarily devoted to studies of proteins and nucleic acids by X-ray diffraction. I was later responsible for changing its profile to include other techniques such as molecular biology, chemistry, and NMR. As a member of the Steering Committee of the ABL-BRP, I participated in directing this multidisciplinary Program, which had been consistently ranked very high among biomedical research institutions. I was involved in the reorganization that followed the incorporation of ABL into the intramural research component of NCI, leading to the creation of the Program in Structural Biology (now terminated). The current Macromolecular Crystallography Laboratory includes components located in both Frederick, MD and Argonne, IL. Between 2001 and 2007 I was a member of the Steering Committee of the Faculty of Chemistry and Structural Biology, NCI.

Education:

Ph.D. in Molecular Biology, March 1974, University of California, Los Angeles (Enrolled July 1969 - March 1974), Dissertation Title: “Studies of Rabbit Muscle Aldolase by X-ray Diffraction,” Advisor: Professor David Eisenberg.

M.S. in Physics (Biophysics), June 1968, University of Warsaw, Poland (Enrolled

September 1963 - June 1968), Thesis Title: “Statistical Analysis of Action Potential Trains in the Visual Neurons of the Cat,” Advisor: Professor Wlodzimierz Kozak (later at Carnegie-Mellon University, now retired).

Employment:

NCI at Frederick
Chief, Macromolecular Crystallography Laboratory
Chief, Protein Structure Section
January 2001 - present

NCI-Frederick Cancer Research and Development Center
Associate Director, Program in Structural Biology
Chief, Macromolecular Crystallography Laboratory
Chief, Protein Structure Section
October 1999 - December 2000

NCI-Frederick Cancer Research and Development Center
ABL-Basic Research Program
Director, Macromolecular Structure Laboratory
Head, Protein Structure Section
October 1987 - October 1999

Center for Chemical Physics, National Bureau of Standards
Group Leader, Macromolecular Structure
October 1984 - September 1987

Reactor Radiation Division, National Bureau of Standards
Physicist, November 1976 - September 1984
Laboratory of Molecular Biology, NIADDK, NIH
Guest Worker, November 1976 - September 1984

Departments of Chemistry and Neurobiology, Stanford University
Postdoctoral Research Associate, March 1974 - June 1975
NIH Fellow, July 1975 - October 1976

Molecular Biology Institute, UCLA
USPHS Trainee, July 1969 - March 1974
Research Assistant, July 1969 - March 1974

National Institute of Health, Rome, Italy
Department of Biological Chemistry
Research Assistant, March - June 1969

Nencki Institute of Experimental Biology, Warsaw, Poland
Department of Neurophysiology
Technical Assistant, October 1968 - January 1969

Professional Societies:

American Crystallographic Association
Protein Society
American Society for Biochemistry and Molecular Biology
International Proteolysis Society

Professional Activities:

Former Elected Officer, American Crystallographic Association
Former Elected Officer, Protein Society
Former Member, Editorial Board, *JOURNAL OF BIOLOGICAL CHEMISTRY*
Member, Editorial Advisory Board, *PROTEIN SCIENCE*
Features Editor, *FEBS JOURNAL*
Member, Editorial Board, *ACTA BIOCHIMICA POLONICA*
Associate Editor, *FEBS Open Bio*
Academic Editor, *PLoS One*
Former Member of a number of *ad hoc* study sections, NIH
Former Member, National Steering Committee for the Advanced Neutron Source
Former Director, Summer School "Determination of High-Resolution Structures for the Post-Genomic Age", Warsaw and Poznan, Poland, June 2001 (under the auspices of the US National Academy of Sciences and funded by the Howard Hughes Medical Institute)
Former Chair, Structural Biology Search Committee, Van Andel Research Institute, Grand Rapids, MI
Former Chair, Chemical Biology Faculty Search Committee, CCR-NCI
Former Member, International Scientific Program Committee, 29th FEBS Congress, Warsaw, Poland, 2004.
Former Member, International Scientific Advisory Board, Synergix, Jerusalem, Israel (1999-2010)
Former Member, Scientific Advisory Board, Center for Drug Design, University of Minnesota, Minneapolis, MN (2003-2010)
Chair, Scientific Advisory Board, Institute of Organic Chemistry and Biochemistry, Prague, Czech Republic (2005-present)
Former Member, Scientific Advisory Board, Institute of Biochemistry and Biophysics, Polish Academy of Sciences, Warsaw, Poland (2006-2016)
Former Member, Scientific Advisory Board, Nencki Institute of Experimental Biology, Polish Academy of Sciences, Warsaw, Poland (2007-2016)
Former Member, Scientific Advisory Board, International Institute of Molecular and Cell Biology, UNESCO and Polish Academy of Sciences, Warsaw, Poland (2010-2017)
Adjunct Professor of Biochemistry and Molecular Biology and Associate Member, the George Washington University Institute of Biomedical Sciences, Washington DC

Postdoctoral Associates:

Lennart Sjölin, 1979-1981 (Now Emeritus Professor, Chalmers University, Gothenburg, Sweden)
Maria Miller, 1981-1982 and 1984-1987 (Now Biologist, Macromolecular Crystallography Laboratory, NCI at Frederick)
Hugh Savage, 1983-1986 (Returned to England, current status unknown)
Robert Harrison, 1985-1987 (Now Professor, Georgia State University, Atlanta, GA)
Joseph Nachman, 1986-1988 (Now Clinical Research Associate, Juravinski Cancer Centre, Hamilton, Ontario, Canada)
Amy Swain, 1988-1991 (Now Program Manager, Biological Systems Science Division, Office of Biological and Environmental Research, US Dept. of Energy, Germantown, MD)
Eric Baldwin, 1990-1991 (Now Associate Director, Biologics Research, Janssen Research and Development, Spring House, PA)
Dominique Housset, 1990-1991 (Now Scientist, LCCP/IBS/CEA, Grenoble, France)
Robert St. Charles 1990-1991 (Now Scientist, GlaxoSmithKline)
Narmada Thanki, 1991-1994 (Now Bioinformatics Staff Scientist, National Center for Biotechnology Information, NIH, Bethesda, MD)
Grzegorz Bujacz, 1993-1997 (Now Professor, Technical University of Łódź, Poland)
Céline Schalk-Hihi, 1993-1997 (Now Senior Scientist, Janssen Research and Development, Spring House, PA)
Jacek Lubkowski, 1992-1998 (Now Associate Scientist, Macromolecular Crystallography Laboratory, NCI at Frederick)
Gottfried Palm, 1994-1998 (Now Staff Scientist, Ernst Moritz Arndt University, Greisfswald, Germany)
Jukka Kervinen, 1995-1998 (Now Technical Specialist, Tosoh Bioscience LLC, King of Prussia, PA)
Lluís Boqué, 1995-1998 (Returned to Spain, current status unknown)
Jiri Vondrasek, 1996-1998 (Now Group Leader, Institute of Organic Chemistry & Biochemistry, Prague, Czech Republic)
Fan Yang, 1997-1999 (Now Project Leader, Novartis Institutes for Biomedical Research, Inc., Cambridge, MA)
David Hoover, 1997-2001 (Now Staff Scientist, Center for Information Technology, NIH, Bethesda, MD)
Narayanasamy Nandhagopal, 1998-2000 (now President, Four Square Enterprises, Chennai, India)
Andreas Hofmann, 1999-2002 (now Associate Professor, Griffith University, Brisbane, Queensland, Australia)
Changsoo Chang, 1999-2004 (Now Associate Scientist, Structural Biology Center, Argonne National Laboratory, Argonne, IL)
Melissa Grella, 2000, (Now Research Scientist, PharmaCore, High Point, NC)
Istvan Botos, 2000-2004 (Now Staff Scientist, National Institute of Diabetes and Digestive and Kidney Diseases, NIH, Bethesda, MD)
Sergei Pletnev, 2001-2005 (Now Leidos Scientist II, Synchrotron Radiation Section, MCL, Argonne, IL)
Nicole LaRonde-LeBlanc, 2002-2006 (Now Associate Professor, University of Maryland, College Park, MD)
Natasza Ziółkowska, 2004-2007 (Now Research Scientist, USAMRIID, Fort Detrick, MD)

Tadashi Satoh, 2007-2008 (Now Associate Professor, Nagoya City University, Nagoya, Japan)
Prasenjit Bhaumik, 2006-2011 (Now Assistant Professor, Indian Institute of Technology, Bombay Powai, India)
Tinoush Moulaei, 2006-2012 (Now Research Scientist, USAMRIID, Fort Detrick, MD)
Zachary Miknis, 2009-2012 (Now Patent Examiner (Biological Sciences), US Patent and Trademark Office, Alexandria, VA)
Jamaine Davis, 2007-2012 (Now Assistant Professor, Meharry Medical College, Nashville, TN)
Dongwen Zhou, 2008-2014 (Now Senior Scientist, CentryMed, Frederick, MD)
Michal Jakob, 2013-2015 (deceased)
Cem Somnez, 2014-2018 (Now Senior Scientist, R&D, HistoGenetics Inc., Ossining, NY)
Pawel Strzelczyk, 2017-

Competitive Grants:

NATO Research Grant 040/80, 1980-1982, Principal Investigator
NIH, 1R01-CA-33741, 1983-1986, Co-principal Investigator
NATO Research Grant 623/83, 1983-1985, Principal Investigator
NSF, PCM-7907501, 1979-1982, Co-principal Investigator
NIH, 1P01-GM-48870, 1992-1997, Principal Investigator
NATO Research Grant CRG 940314, 1994-1999, Principal Investigator
Howard Hughes Medical Institute International Grant, 1995-2000, U.S. Collaborator
NIH, 1P01-GM-48870-06, 1997-2002, Principal Investigator
US Civilian Research and Development Foundation, 2003-2005, Principal Investigator
IATAP NIH Intramural grant, 2007-2010, Principal Investigator
IATAP NIH Intramural grant, 2012-2014, Co-principal Investigator

Honors:

NIH National Research Service Award, 1975-1976
National Bureau of Standards, Outstanding Performance Rating, 1978, 1982, and 1984
U.S. Department of Commerce Bronze Medal, 1982
U.S. Department of Commerce Silver Medal, 1986
Australian Society for Biochemistry, Plenary Lecturer, Canberra, Australia, 1991
Welch Foundation Conference on Chemical Research, Invited Lecturer, Houston, TX, 1991
Israel Crystallographic Society, Fred Hirshfeld Memorial Plenary Lecturer, Rehovot, Israel, 1993
S. Gustaffson Symposium, Invited Lecturer, Stockholm, Sweden, 1993
The Second De Lange Conference, Invited Lecturer, Houston, TX, 1994
Page-Wood Symposium, Case Western University, Invited Lecturer, Cleveland, OH, 1994
Mór Kaposi Research Foundation Conference, Invited Lecturer, Budapest, Hungary, 1996
American Society for Biochemistry and Molecular Biology, Invited Lecturer, New Orleans, LA 1996

Austrian Chemical Society, Invited Lecturer, Vienna, Austria, 1997
European Crystallographic Meeting 18, Plenary Lecturer, Prague, Czech Republic, 1998
Fifth International Union of Biochemistry and Molecular Biology Conference, Session Chairman and Invited Lecturer, Jerusalem, Israel, 1998
Elected Visiting Fellow, Sidney Sussex College, Cambridge, England, October 1998 - March 1999
Leo Sternbach Symposium, Hoffman-La Roche, Plenary Lecturer, Nutley, NJ, 1999
Mór Kaposi Research Foundation Conference, Invited Lecturer, Budapest, Hungary, 2000
Biozentrum Basel, 30th Anniversary Symposium, Invited Lecturer, Basel, Switzerland, 2001
European Crystallographic Meeting 21, Session Chairman and Invited Speaker, Durban, South Africa, 2003
Federation of European Biochemical Societies 29th Congress, Session Chairman and Invited Speaker, Warsaw, Poland, 2004
Heart of Europe Biocrystallographic Conference, Invited Plenary Speaker, Krzyzowa, Poland, 2004
Technical University of Lódz, Poland, *Doctor Honoris Causa*, 2004
XXth Congress of the International Union of Crystallography, Session Organizer/ Chairman and Invited Speaker, Florence, Italy, 2005
International Proteolysis Society, 4TH General Meeting, Session Organizer/Chairman, Quebec City, Canada, 2005
Polish Academy of Sciences, Elected Foreign Member, Warsaw, Poland, 2005
3rd Central European Conference Chemistry towards Biology, Invited Plenary Speaker, Krakow, Poland, 2006
NCI Mentor of Merit Award, 2006
European Crystallographic Meeting 25, Invited Speaker, Marrakesh, Morocco, 2007
Jaroslav Heyrovsky Honorary Medal for Merit in Chemical Sciences, Czech Academy of Sciences, Prague, Czech Republic, 2008
Polish Chemical Society, 52nd Congress, Plenary Lecturer, Lódz, Poland, 2009
Brazilian Society of Biochemistry and Molecular Biology, 40th Meeting, Plenary lecture sponsored by the Pan-American Association for Biochemistry and Molecular Biology, Foz do Iguassu, Brazil, 2011
IX European Symposium of The Protein Society, Session Organizer and Invited Speaker, Stockholm, Sweden, 2011
VIIIth Parnas Conference of the Polish, Ukrainian, and Israeli Biochemical Societies, Keynote speaker, Warsaw, Poland, 2011
Multi-Pole Approach to Structural Biology, Organizer, Session Chairman, and Invited Speaker, Warsaw, Poland, 2011
IXth Parnas Conference of the Polish, Ukrainian, and Israeli Biochemical Societies, Keynote speaker, Jerusalem, Israel, 2013
American Crystallographic Association Fellow, 2013
The Kosciuszko Foundation, Distinguished Fellow of the Collegium of Eminent Scientists, 2014
International Union of Crystallography 23rd Congress, Session Organizer and Chair, Montreal, Canada, 2014
American Association for the Advancement of Science – Foundation for Polish Science

Award for Collaborative Research (with Prof. Mariusz Jaskolski), 2015
Federal Technology Transfer Award, 2015
Challenges in Molecular Biology, Biophysics, and Biomedicine, Keynote speaker, Warsaw, Poland, 2015
Japan Society for the Promotion of Science Invitation Fellowship, Tokyo-Kyoto, Japan, 2015
2nd Congress Bio2016, Plenary Opening Lecture, Wroclaw, Poland, 2016

Publications

1. "Ultracentrifiguration at moderate pressures," V.N. Schumaker, A. Wlodawer, J.T. Courtney, and K.M. Decker, *Anal. Biochem.* **34**, 359-365 (1970).

2. "Precision of a rotating drum film scanner," A. Wlodawer, *J. Appl.* Crystallogr. **7**, 19-21 (1974).

3. "Crystallization and crystal data of monellin," A. Wlodawer and K.O. Hodgson, *Proc. Natl. Acad. Sci. USA* **72,** 398-399 (1975).

4. "Crystallization of nerve growth factor from mouse submaxillary glands," A. Wlodawer, K.O. Hodgson, and E.M. Shooter, *Proc. Natl. Acad. Sci. USA* **72**, 777-779 (1975).

5. "Studies of two crystal forms of L-glutaminase-asparaginase from *Acinetobacter glutaminasificans,"* A. Wlodawer, K.O. Hodgson, and K. Bensch, *J. Mol. Biol.* **99**, 295-299 (1975).

6. "Fourier transform NMR spectroscopy and its application in the studies of conformational changes of the proteins with low molecular weight," B. Lubas, A. Blum, and A. Wlodawer, *Proceedings of the 8th Symposium on NMR Applications*, p. 185 - 198, Cracow, Poland (1975).

7. "Applications of synchrotron radiation to protein crystallography—preliminary results," J.C. Phillips, A. Wlodawer, M.M. Yevitz, and K.O. Hodgson, *Proc. Natl. Acad. Sci. USA* **73**, 128-132 (1976).

8. "On the application of synchrotron radiation to X-ray diffraction—polarization and anomalous scattering," J.C. Phillips, A. Wlodawer, and K.O. Hodgson, *Report 76/01*, SSRP, Stanford University, Stanford, CA (1976).

9. "Applications of synchrotron radiation to protein diffraction," K.O. Hodgson, J.C. Phillips, and A. Wlodawer, *Trans. Am. Cryst. Assoc.* **12**, 1-9 (1976).

10. "Applications of synchrotron radiation to protein crystallography. ii: Anomalous scattering, absolute intensity and polarization," J.C. Phillips, A. Wlodawer, J.M. Goodfellow, K.D. Watenpaugh, L.C. Sieker, L.H. Jensen, and K.O. Hodgson, *Acta Crystallogr*. **A33**, 445-455 (1977).

11. "Characterization of crystals of L-glutaminase-asparaginase from *Acinetobacter glutaminasificans* and *Pseudomonas 7A*," A. Wlodawer, J. Roberts, and J.S. Holcenberg, *J. Mol. Biol*. **112**, 515-519 (1977).

12. "Flat-cone diffractometer utilizing a linear position-sensitive detector," E. Prince,

A. Wlodawer, and A. Santoro, *J. Appl. Cryst.* **11**, 173-178 (1978).

13. "Leucine aminopeptidase (bovine lens): An electron microscopic study," A. Taylor, F.H. Carpenter, and A. Wlodawer, *J. Ultrastructure Res*. **68**, 92-100 (1979).

14. "High-density lipoprotein recombinants: Evidence for a bicycle tire micelle structure obtained by neutron scattering and electron microscopy," A. Wlodawer, J.P. Segrest, B. H. Chang, R. Chiovetti, and J.N. Weinstein, *FEBS Lett.* **104**, 231-235 (1979).

15. "Absorption correction for Weissenberg diffractometers," A. Santoro and A. Wlodawer, *Acta Crystallogr.* **A36**, 442-450 (1980).

16. "Studies of ribonuclease-A by X-ray and neutron diffraction," A. Wlodawer, *Acta* Crystallogr. **B36**, 1826-1831 (1980).

17. "Preliminary investigation of a new X-ray film," S. Abrahamsson, O. Lindqvist, L. Sjölin, and A. Wlodawer, *J. Appl. Cryst*. **14**, 256-260 (1981).

18. "Improved technique for peak integration for crystallographic data collected with position-sensitive detectors: A dynamic mask procedure," L. Sjölin and A. Wlodawer, *Acta Crystallogr*. **A37**, 594-604 (1981).

19. "Orientation of histidine residues in RNase A: Neutron diffraction study," A. Wlodawer and L. Sjölin, *Proc. Natl. Acad. Sci. USA* **78**, 2853-2855 (1981).

20. "Active conformation of an inactive semi-synthetic ribonuclease-S," H.C. Taylor, D.C. Richardson, J.S. Richardson, A. Wlodawer, A. Komoriya, and I.M. Chaiken, *J. Mol. Biol*. **149**, 313-317 (1981).

21. "Refinement of the crystal orientation matrix for the flat-cone diffractometer," A. Wlodawer, L. Sjölin, and A. Santoro, *J. Appl. Cryst*. **15**, 79-81 (1982).

22. "The refined crystal structure of ribonuclease A at 2.0 Å resolution," A. Wlodawer, R. Bott, and L. Sjölin, *J. Biol. Chem.* **257**, 1325-1332 (1982).

23. "A procedure for joint refinement of macromolecular structures with X-ray and neutron diffraction data from single crystals," A. Wlodawer and W.A. Hendrickson, *Acta Crystallogr*. **A38**, 239-247 (1982).

24. "Hydrogen exchange in RNase A: Neutron diffraction study," A. Wlodawer and L. Sjölin, *Proc. Natl. Acad. Sci. USA* **79**, 1418-1422 (1982).

25. "Improvement of the quality of the data collected using a position-sensitive detector," A. Wlodawer and L. Sjölin, *Nucl. Instrum. Methods* **201**, 117-122 (1982).

26. "Neutron diffraction of crystalline proteins," A. Wlodawer, *Prog. Biophys. Mol. Biol.*

40, 115-159 (1982).

27. "Diffraction and NMR studies of proteins; an uneasy alliance," J.S. Cohen and A. Wlodawer, *Trends Biochem. Sci.* **7**, 389-391 (1982).

28. "Conformational studies of polypeptide growth factors: IGF and NGF," J. Gunning, S. Bedarkar, G.L. Taylor, J.M. Goodfellow, T.L. Blundell, A. Wlodawer, K.O. Hodgson, E.M. Shooter, R. Fourme, B. Gaber, and R. Williams, in *Cell Function and Differentiation*, Part A, Alan R. Liss, Inc.: New York, NY, pp. 221-230 (1982).

29. "The molecular symmetry of glutaminase-asparaginases: Rotation function studies of the *Pseudomonas 7A* and *Acinetobacter* enzymes," H.L. Ammon, K. C. Murphy, L. Sjölin, A. Wlodawer, J.S. Holcenberg, and J. Roberts, *Acta Crystallogr*. **B39**, 250-257 (1983).

30. "Structure of ribonuclease A: Results of joint neutron and x-ray refinement at 2.0 Å resolution," A. Wlodawer and L. Sjölin, *Biochemistry* **22**, 2720-2728 (1983).

31. "Active site of RNase: Neutron diffraction study of a complex with uridine vanadate, a transition-state analog," A. Wlodawer, M. Miller, and L. Sjölin, *Proc. Natl. Acad. Sci. USA* **80**, 3628- 3631 (1983).

32. "Preliminary x-ray analysis of single crystals of ovalbumin and plakalbumin," M. Miller, J.N. Weinstein, and A. Wlodawer, *J. Biol. Chem*. **258**, 5864-5866 (1983).

33. "Application of joint neutron and x-ray refinement to the investigation of the structure of ribonuclease A at 2.0 Å resolution," A. Wlodawer and L. Sjölin, in *Neutrons in Biology*, B.P. Schoenborn, ed., Plenum Press: New York, NY, pp. 349-364 (1984).

34. "Structure of bovine pancreatic ribonuclease," A. Wlodawer, in *Biological Macromolecules and Assemblies, Vol. II: Nucleic Acids and Interactive Proteins*, A. McPherson and F. Jurnak, eds., John Wiley: New York, NY, pp. 393-439 (1984).

35. "Structure of bovine pancreatic trypsin inhibitor: Results of joint neutron and x-ray refinement of crystal form II," A. Wlodawer, J. Walter, R. Huber, and L. Sjölin, *J. Mol. Biol.* **180**, 301-331 (1984).

36. "Nuclear magnetic resonance and neutron diffraction studies of the complex of RNase A with uridine vanadate, a transition-state analog," B. Borah, C. Chen, W. Egan, M. Miller, A. Wlodawer, and J. Cohen, *Biochemistry* **24,** 2058-2067 (1985).

37. "A facility for data collection and processing at the National Bureau of Standards reactor," A. Wlodawer, *Methods Enzymol.* **114**, 551-564 (1985).

38. "Preliminary crystallographic study of an L-asparaginase from *Vibrio succinogenes*," H.L. Ammon, K.C. Murphy, K. Chandrasekhar, and A. Wlodawer, *J. Mol. Biol.* **184,** 179-181 (1985).

39. "Determination of water structure around biomolecules using x-ray and neutron diffraction methods," H. Savage and A. Wlodawer, *Methods Enzymol.* **127**, 162-183 (1986).

40. "Comparison of two independently refined models of ribonuclease A," A. Wlodawer, N. Borkakoti, D.S. Moss, and B. Howlin, *Acta Crystallogr*. **B42**, 379-387 (1986).

41. "Experience with the use of a neutron protein data collection facility equipped with an area detector," A. Wlodawer and L. Sjölin, *J. Physique* **47**, C5, 115-121 (1986).

42. "Neutron crystallography of proteins," N.V. Raghavan and A. Wlodawer, in *Methods in Experimental Physics: Neutron Scattering*, K. Sköld and D.L. Price, eds., Academic Press, Orlando, FL, Vol. 23, pp. 335-365 (1987).

43. "Comparison of two highly refined structures of bovine pancreatic trypsin inhibitor," A. Wlodawer, J. Deisenhofer, and R. Huber, *J. Mol. Biol.* **193**, 145-156 (1987).

44. "Multiple conformations of amino acid residues in ribonuclease A," L.A. Svensson, L. Sjölin, G.L. Gilliland, B.C. Finzel, and A. Wlodawer, *Proteins: Struct. Funct. Genet*. **1**, 370-375 (1987).

45. "Crystallization of a DNA duplex 15-mer containing unpaired bases: d(CGCGAAATTTACGCG)," M. Miller, A. Wlodawer, E. Appella, and J.L. Sussman, *J. Mol. Biol.* **195**, 967-968 (1987).

46. "Crystal structures of bacterial glutaminase-asparaginases," R.W. Harrison, I.T. Weber, H.L. Ammon, K.C. Murphy, A. Wlodawer, G.L. Gilliland, and J. Roberts, in *Protein Structure and Design, UCLA Symposia on Molecular and Cellular Biology*, New Series, Vol. 69, pp. 83-92 (1987).

47. "Crystal structure of phosphate-free ribonuclease," A. Wlodawer, G.L. Gilliland, L. Sjölin, and L.A. Svensson, in *Protein Structure and Design*, *UCLA Symposia on Molecular and Cellular Biology*, New Series, Vol. 69, pp. 109-118 (1987).

48. "Structure of form III crystals of bovine pancreatic trypsin inhibitor," A. Wlodawer, J. Nachman, G.L. Gilliland, W. Gallagher, and C. Woodward, *J. Mol. Biol.* **198**, 469-480 (1987).

49. "Preliminary crystal structure of *Acinetobacter glutaminasificans* glutaminase-asparaginase," H.L. Ammon, I.T Weber, A. Wlodawer, R.W. Harrison, G.L. Gilliland, K.C. Murphy, L. Sjölin, and J. Roberts, *J. Biol. Chem.* **263**, 150-156

(1988).

50. "Structure of phosphate-free ribonuclease A refined at 1.26 Å," A. Wlodawer, L.A. Svensson, L. Sjölin, and G.L. Gilliland, *Biochemistry* **27,** 2705-2717 (1988).

51. "Crystal structure of 15-mer DNA duplex containing unpaired bases," M. Miller, R.W. Harrison, A. Wlodawer, E. Appella, and J.L. Sussman, *Nature* **334**, 85-86 (1988).

52. "Analysis of solvent structure and hydrogen exchange in proteins on the basis of neutron diffraction data from deuterated and hydrogenous crystals," R. Harrison, A. Wlodawer, and L. Sjölin, *Acta Crystallogr.* **A44**, 309-320 (1988).

53. "Structures of amidohydrolases: Amino acid sequence of a glutaminase-asparaginase from *Acinetobacter glutaminasificans* and preliminary crystallographic data for an asparaginase from *Erwinia chrysanthemi*," S. Tanaka, E.A. Robinson E. Appella, M. Miller, H.L. Ammon, I.T. Weber, and A. Wlodawer, *J. Biol. Chem.* **263,** 8583-8591 (1988).

54. "A preliminary crystallographic study of a retroviral protease," M. Miller, J. Leis and A. Wlodawer, *J. Mol. Biol*. **204,** 211-212 (1988).

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