

# CURRICULUM VITAE

**John Frank Carpenter**

## ***I. GENERAL INFORMATION***

*Office Address:* School of Pharmacy  
Campus Box C238  
University of Colorado Health  
Sciences Center  
Denver, CO 80262

*Office Telephone:* 303-315-6075  
*Office FAX:* 303-315-6281

## ***II. EDUCATION***

YEAR	INSTITUTION	DEGREE OBTAINED
1978	Duke University	B.S., Zoology (Magna cum laude)
1981	Oregon State University	M.S., Zoology (Biochemistry minor)
1985	Univ. of Louisiana, Lafayette	Ph.D., Biology

## ***III. PROFESSIONAL EXPERIENCE***

YEAR	TITLE	INSTITUTION
1978-1981	Graduate Student	Oregon State University (Dept. of Zoology)
1981-1982	Hatchery Manager	Laguna Madre Shrimp Farm Harlingen, TX
1982-1985	Graduate Student	Univ. of SW Louisiana (Biology Department)
1986-1988	Postdoctoral Associate	Univ. of California, Davis (Zoology Department)
1988-1992	Senior Scientist	CryoLife, Inc. Marietta, GA

#### ***IV. ACADEMIC APPOINTMENTS***

YEAR	TITLE	INSTITUTION
1987-1988	Visiting Lecturer	Univ. of California, Davis
1993-1998	Assistant Professor of Pharmaceutical Biotechnology	University of Colorado
1993-present	Graduate Faculty	Univ. of Colorado Health Sciences Center
1997-present	Co-Founder and Co-Director Center for Pharmaceutical Biotechnology	University of Colorado
1997-present	Graduate Faculty	Univ. of Colorado, Boulder
1998-present	Associate Professor of Pharmaceutical Biotechnology	Univ. of Colorado HSC
2000-present	Associate Director Pharmaceutical Biotechnology Graduate Training Program	Univ. of Colorado HSC
2001-present	Co-Director, NIH Training Grant, Leadership Training in Pharmaceutical Biotechnology	Univ. of Colorado
2003-present	Director Pharmaceutical Biotechnology Graduate Training Program	Univ. of Colorado HSC
2004-present	Professor of Pharmaceutical Biotechnology	Univ. of Colorado HSC

#### ***V. CONSULTING ACTIVITIES***

**Consultant for:**

Numerous pharmaceutical and biotechnology companies

**Member of Scientific Advisory Board for:**

Governor's Council on Biotechnology, Colorado, 2001- present  
 [REDACTED], 2002-present  
 [REDACTED], 2003-present  
 [REDACTED], 2003-present  
 [REDACTED], 2003-present

**VI. TEACHING ACTIVITY**

YEAR	COURSE	SEMESTER CREDITS	NO. OF STUDENTS	CONTACT HRS
<i>University of California, Davis</i>				
1987	Human Physiology	3	180	45 lecture
1988	Human Physiology	3	180	45 lecture
<i>University of Colorado (*Course Coordinator)</i>				
1993	*PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	130	60 lecture
1993	PHSC 7656 Advanced Pharmaceutics	1.3	3	4 lecture
1994	*PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	140	60 lecture
1994	PHSC 7800 Molecular Biol.	2.7	40	2 lecture
1995	*PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	135	50 lecture
1995	PHSC 7800 Molecular Biol.	2.7	30	2 lecture
1996	*PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	135	50 lecture
1996	*PHSC 7341 Graduate Physiology	2	6	30 lecture
1996	PHSC 7800 Molecular Biol.	2.7	35	4 lecture

1997 *PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	125	40 lecture
1997 PHSC 7800 Molecular Biol.	2.7	50	4 lecture
1997 Pharm.D. Pathophysiology	4	70	7 lecture
1997 Graduate Protein Chemistry	4	12	6 lecture
1997 *PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	105	30 lecture
1998 Pharm.D. Pathophysiology	4	70	7 lecture
1998 Graduate Protein Chemistry	4	12	10 lecture
1998 *PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	105	30 lecture
1999 *PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	90	30 lecture
1999 Track-In Pharm.D. Pathophys.	4	50	5 lecture
1999 Grad. Protein Chem.	3	6	5 lecture
2000 Track-In Pharm.D. Pathophys.	4	50	5 lecture
2000 *PHSC 3410 Physiology/ Pathophys. for Therapeutics	4	90	15 lecture
2001 Integrated Organ Systems I Physiology	4	90	14 lecture
2001 Grad. Protein Chem.	3	6	5 lecture
2002 *Integrated Organ Systems I Physiology	4	110	14 lecture
2002 Intergrated Organ Systems IV Pathophysiology	4	90	4 lecture
2002 *Grad. Issues in Drug Develop.	2	12	2 lecture

2003 *Grad. Protein Formulation	2	10	28 lecture
2003 *Integrated Organ Systems I Physiology	4	110	14 lecture
2003 Grad. Protein Chem.	3	6	5 lecture

*Other*

Lecturer, "Principles of Physiology", School of Pharmacy Minority Student Summer Orientation Program, 1994  
 Lecturer, "Principles of Physiology", School of Pharmacy Minority Student Summer Orientation Program, 1995  
 Lecturer, "Principles of Physiology", School of Pharmacy Minority Student Summer Orientation Program, 1996  
 Lecturer, "Principles of Physiology", School of Pharmacy Minority Student Summer Orientation Program, 1997  
 Invited Lecturer, Parenteral Drug Association Workshop on "Formulating Stable Biotechnology Products", New Brunswick, NJ, 1995  
 Invited Lecturer, Conference on Pharmaceutical Science and Technology Workshop on "Formulating Stable Protein Pharmaceutical Products", Chicago, IL, 1995  
 Invited Lecturer, Parenteral Drug Association Workshop on "Formulating Stable Biotechnology Products", San Diego, 1995  
 Co-Organizer and Co-Chair (with Drs [REDACTED] and [REDACTED]), "Annual Graduate Student Symposium in Pharmaceutical Biotechnology", 1995-1997  
 Lecturer and Organizer, "A Hands-On Course on Analysis of Protein Structure with Infrared Spectroscopy", Denver, CO, 1998  
 Lecturer and Co-organizer, "Protein Formulation Development Shortcourse", Breckenridge, CO, 2002, 2003

**VII. ADVISING ACTIVITY**

*Thesis Advisor for Ph.D. Students*

University of Colorado, Department of Pharmaceutical Sciences

[REDACTED] (Ph.D., 1998)  
 [REDACTED] (Ph.D., 1997)  
 [REDACTED] (Ph.D., 1999)  
 [REDACTED] (Ph.D., 2001)  
 [REDACTED] (Ph.D., 2002)  
 [REDACTED] (Ph.D., 2002)  
 [REDACTED] (2001-present)



Other Institutions

[Redacted], Co-Advisor, (Ph.D., 1998)  
[Redacted], Co-Advisor, (Ph.D., 2002)  
[Redacted], Co-Advisor, (Ph.D., 2003)

*Member of Advisory Committee*

University of Colorado, Department of Pharmaceutical Sciences

[Redacted] (Ph.D., 1996)  
[Redacted] (Ph.D., 2002)  
[Redacted] (2003-present)  
[Redacted] (2003-present)

Other Institutions

[Redacted] Dept. of Chemical Engineering, Yale University (Ph.D., 1995)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 2001)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 2001)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 1998)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 2001)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 2002)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 2001)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (M.S., 2000)  
[Redacted] Dept. of Chemical Engineering, University of Colorado (Ph.D., 2004)  
[Redacted] Dept. of Chemical Engineering, University of Colorado

*Mentor for Postdoctoral Research Associates*

[Redacted], Ph.D.  
[Redacted], Ph.D.  
[Redacted], Ph.D.  
[Redacted], Ph.D.  
[Redacted], Ph.D.  
[Redacted], Ph.D.

[REDACTED], Ph.D.  
[REDACTED], Ph.D.  
[REDACTED], Ph.D.  
[REDACTED], Ph.D.

### ***VIII. ADMINISTRATIVE ACTIVITY AND UNIVERSITY SERVICE***

DOPS Research Committee, 1995-2000  
Graduate Program Committee, 1993-1996  
Continuing Education Committee, 1993-1994  
Core Course ad hoc Committee, 1993  
DOPS Seminar Committee, Co-Chair, 1993-1994, 1997  
Faculty Search Committee, 1993-1994  
UCHSC Technology Transfer Committee, 1997-1999  
SOP Scholastic Advancement Affairs Committee, 1997-1999  
UCHSC Indirect Cost Waiver Committee, 1998-2000  
DOPS Faculty Search Committee, 1997, 1998, 1999, 2000, 2002, 2003  
[REDACTED]  
CU Intellectual Property Committee, 1999-present  
Chair, SOP Students Ethics and Conduct Committee, 1999-2000  
Member, SOP Space Committee, 2000  
Member, CU Technology Transfer Advisory Board, 2002-present  
Member, Fitzsimons Biosciences Park Advisory Board, 2002-present  
[REDACTED]

### ***IX. HONORS***

Avis Distinguished Visiting Professor, Univ. of Tennessee College of Pharmacy, 2005  
Keynote Speaker, Univ. of Minnesota Drug Delivery Center Open House, 2004  
Keynote Speaker, IBC Protein Formulation Conference, 2004  
Keynote Speaker, IIR Protein Formulation and Delivery Conference, 2004  
Keynote Speaker, IBC Protein Formulation Conference, 2003  
Fellow, American Association of Pharmaceutical Scientists, 2002  
Keynote Speaker, ACS Colorado Student Awards Banquet, 1999  
Chancellor's Teaching Recognition Award, UCHSC Graduate School, 1998  
Excellence in Teaching Award, University of Colorado School of Pharmacy, 1998  
Eli Lilly Young Investigator in Pharmaceutical Sciences Award, 1998-1999  
Plenary Lecturer, Colorado Institute for Research in Biotechnology Meeting, 1995  
Excellence in Teaching Award, University of Colorado School of Pharmacy, 1995  
Excellence in Teaching Award, University of Colorado School of Pharmacy, 1994  
Keynote Address, American Chemical Society National Meeting, 1994  
Excellence in Teaching Award, University of Colorado School of Pharmacy, 1993  
Invited Participant, The Timasheff Symposium, 1992  
Invited Discussant for 10th International Conference on  
    Comparative Physiology, Crans-Sierre, Switzerland, 1990  
Honor Graduate, University of Southwestern Louisiana, 1985

President's Honor Convocation, USL, 1984-1985  
Rockefeller Memorial Scholarship, 1982-1985  
Sigma Xi Research Grant, 1984  
American Heart Assc. Predoctoral Fellowship, 1983-1984  
Dean's List, Oregon State University, 1978-1980  
Commendation for Teaching Excellence, 1978-1981  
Department of Zoology, Oregon State University  
Duke University Class Honors and Dean's List, 1974-1978

## ***X. PROFESSIONAL ACTIVITY AND PUBLIC SERVICE***

### *A. Membership in Professional Organizations*

American Association of Pharmaceutical Scientists (AAPS)  
American Association for the Advancement of Science  
Biophysical Society

### *B. Service in Professional Organizations*

Member, Finance Committee, Society for Cryobiology, 1990-1993  
Treasurer, Society for Cryobiology, 1991-1993  
Member, Executive Committee, Society for Cryobiology, 1991-1993  
Member, Program Committee, Society for Cryobiology, 1993-1994  
Member, Board of Governors, Society for Cryobiology, 1993-1995  
Chair, Finance Committee, Society for Cryobiology, 1993-1995  
Member, Publications Committee, Society for Cryobiology, 1996-1997  
Member, BIOTEC Section Fellows Committee, AAPS, 1996  
Member, BIOTEC Section Program Committee, AAPS, 1996  
Member, Education Committee, AAPS, 1996  
Member, Organizing Committee, AAPS Western Regional Meeting, 1997  
Member, Publicity Committee, World Millennial Conference on Pharmaceutical Sciences, 1999-2000  
Member, BIOTEC Section Fellows Committee, AAPS, 2003  
Member, AAPS Publications Advisory Board, 2003-present  
Chair, AAPS Books Subcommittee, 2004-present  
Chair, BIOTEC Section Fellows Committee, AAPS, 2004

### *C. Journal Referee*

*American Journal of Physiology*  
*American Chemical Society Symposium Series*  
*American Journal of Drug Delivery*  
*American Zoologist*  
*American Zoologist*



*Archives of Biochemistry and Biophysics*  
*Archives of Insect Biochemistry and Physiology*  
*Biochimica et Biophysica Acta*  
*Biochemistry*  
*Biochemistry and Cell Biology*  
*BioPharm*  
*Biophysical Chemistry*  
*Biophysical Journal*  
*Biopolymers*  
*Biopolymers: Peptide Science*  
*BioTechniques*  
*Biotechnology and Bioengineering*  
*Biotechnology Progress*  
*Carbohydrate Chemistry*  
*Comparative Biochemistry and Physiology*  
*Cryobiology*  
*Cryo-Letters*  
*Drug Development and Industrial Pharmacy*  
*European Journal of Biochemistry*  
*International Journal of Pharmaceutics*  
*Journal of Agriculture and Food Chemistry*  
*Journal of Biological Chemistry*  
*Journal of Controlled Release*  
*Journal of Experimental Biology*  
*Journal of Experimental Zoology*  
*Journal of Molecular Biology*  
*Journal of Pharmaceutical Sciences*  
*Journal of Physical Chemistry*  
*Pharmaceutical Research*  
*PharmSci*  
*PharmSciTechnology*  
*Photochemistry and Photobiology*  
*The Plant Journal for Cell and Molecular Biology*  
*Proceedings of the National Academy of Sciences*  
*Protein Engineering*  
*Protein Engineering, Design and Selection*  
*Protein Science*

*D. Grant Review Panels*

Alzheimer's Association, 2001  
National Science Foundation, ad hoc Reviewer  
Molecular Biophysics, 1993-1995  
Physiological Ecology, 1994-1995  
Biochemistry & Molecular Structure and Function, 1994-1995  
Integrative Plant Biology, 1995

Ecological and Evolutionary Physiology, 1996, 1998  
Antarctic Biology and Medicine, 1996, 2000  
Bioengineering and Environmental Sciences, 1999  
Arctic Natural Sciences, 2003  
Office of Naval Research, ad hoc Reviewer, 1994  
Sea Grant Program, ad hoc Reviewer, 1993-1994  
Colorado Institute in Biotechnology, 1995, 1999  
USAMRMC Breast Cancer Research Program, Research with Translational  
Potential Study Section, 1996  
National Institutes of Health, NIGMS, ad hoc Reviewer, 1997  
American Association of Colleges of Pharmacy, New Investigator Awards, 2003

#### *E. Editorial Boards*

*Cryobiology*, 1991-present  
*Journal of Pharmaceutical Sciences*, 1994-present  
*Pharmaceutical Research*, 1997-present  
*BioPharm*, 1998-present  
*PharmSci*, 1999-present  
*Current Pharmaceutical Biotechnology*, 1999-present  
*Cell Preservation Technology*, Associate Editor, 2002-present  
*Molecular Pharmaceutics*, 2003-present  
*Journal of Biological Chemistry*, 2003-present

#### *F. Other*

Co-Organizer and Co-Chair (with Prof. Serge Timasheff), "Workshop on Protein Stability", Annual Meeting of Cryobiology Soc., Leuven, Belgium, 1991  
Co-Organizer and Co-Chair (with Profs. John Crowe, George Somero, James Clegg), "Compatible Solutes and Macromolecular Stability: A Colloquium of the Bodega Bay Marine Laboratory", Bodega Bay, CA, 1992  
Member, Organizing Committee, Annual Meeting of Cryobiology Society, Atlanta, GA, 1993  
Organizer and Chair, "Session on Protein Storage Stability", BioPharm Conference, San Francisco, CA, 1994  
Co-Organizer and Co-Chair (with Ted Randolph et al.), "Colorado Protein Stability Conference", 1994, 1996, 1998, 2000, 2002, 2003, 2005  
Co-Organizer and Co-Chair (with Dr. Michael Pikal), "Symposium on Protein Lyophilization", American Chemical Society Conference on Formulations and Drug Delivery, Boston, MA, 1995  
Member, Program Committee, "1995 Conference on Pharmaceutical Science and Technology" in conjunction with the 1995 International Conference on Food Science and Technology and the 26th Annual Meeting of the Fine Particle Society  
Co-Host (with [REDACTED]), Visiting Professor, Prof [REDACTED], Chair,

Dept. of Biology, Furman University, 1995-1996  
 Host, Visiting Scholar, Dr. [REDACTED] National Institute of Health Sciences,  
 Tokyo, Japan, 1995-1997  
 Co-Organizer and Co-Chair (with Dr. Ted Randolph), "Symposium on Protein  
 Stabilization", American Chemical Society National Meeting, New  
 Orleans, LA, 1996  
 Member, Organizing Committee, American Chemical Society Conference on Drug  
 Stability and Delivery, San Diego, 1997  
 Chair, Fund Raising Committee, American Chemical Society Conference on Drug  
 Stability and Delivery, San Diego, 1997  
 Co-Organizer, "Colorado Biopharmaceutical Delivery Conference", 1997  
 Co-Organizer and Co-Chair, Session on Protein Formulation, American Chemical  
 Society Conference on Drug Stability and Delivery, San Diego, 1997  
 Co-Organizer and Co-Chair, Symposium on Protein-Excipient Interactions,  
 Western Regional AAPS Meeting, San Francisco, CA, 1998  
 Member, Publicity Committee, World Millennial Pharmaceuticals Conference, 1999  
 Organizer, Student Lunch and Learn Session on Industrial Careers, AAPS  
 National Meeting, Boston, MA, 1997  
 Member, Organizing Committee, Conference on Biopharmaceutical Lyophilization,  
 Vermont, 1998  
 Organizer, Session on Advanced Analytical Methods, BioPharm Conferences, East  
 (Boston) and West (San Francisco), 1999  
 Organizer, Session on Formulation of Biopharmaceuticals for Delivery Systems,  
 BioPharm Conferences, East (Boston) and West (San Francisco), 1999  
 Co-Organizer, Macromolecular Drug Delivery Conference, Breckenridge, CO,  
 1999, 2001  
 Co-Organizer, DARPA Conference on Stabilization of Dried Biomaterials,  
 Breckenridge, CO, 1999  
 Organizer, Symposium on Protein Powders, AAPS Drug Delivery Conference  
 Alexandria, VA, 2002  
 Co-Organizer, IBC Conference on Protein Formulations, Philadelphia, 2003  
 Organizer and Session Chair, Protein Formulation Symposium, Protein Society Annual  
 Meeting, San Deigo, CA, 2004

***XI. INVITED SPEAKING ENGAGEMENTS***

Local and State

YEAR	ORGANIZATION	TITLE
1986	California State Univ. Hayward, CA	Intracellular pH and Regulation of Phosphofructokinase
1988	Protein Chemistry Dept. Amgen, Inc., Thousand Oaks, CA	Stabilization of Proteins during Freezing and Drying

1992	Dept. of Physiology and Endocrinology, Medical College Georgia, Augusta	Stabilization of Proteins during Freezing and Drying
1993	Synergen, Inc. Boulder, CO	Stabilization of Proteins during Freezing and Drying
1993	BioStar, Inc. Boulder, CO	Stabilization of Proteins during Freezing and Drying
1993	Cell and Molecular Biology Program, Colorado State Univ., Fort Collins, CO	Stabilization of Proteins during Freezing and Drying
1993	Department of Chemistry Denver University	Stabilization of Proteins during Freezing and Drying
1993	Webb Waring Lung Institute, Denver, CO	Stabilization of Proteins during Freezing and Drying
1995	37th Annual Rocky Mountain Analytical Chemistry Conference Denver, CO	Stabilization of Protein during Freezing and Drying
1995	Annual Meeting of Colorado Institute for Biotechnology Boulder, CO	Application of Infrared Spectroscopy to Stabilization of Proteins during Freeze Drying
1997	Experimental Therapeutics Group Medical Oncology Division UCHSC Denver, CO	Stabilization of Proteins during Freeze Drying
1998	Dept. of Chemistry/Biochemistry Univ. of Northern Colorado Greeley, CO	Stabilization of Protein Therapeutics
1999	CIRES, Univ. of Colorado Boulder, CO	Stabilization of Proteins during Freezing and Drying
2001	UCHSC Biomolecular Structure Program	Thermodynamic Modulation of Protein Aggregation and Amyloid Fibril Formation
2003	Eppendorf Boulder, CO	Rational Design of Stable Lyophilized Protein Formulations

2004	Molecular Biology Program Colorado State Univ. Ft. Collins, CO	Aggregation of Proteins in Aqueous Solution: Mechanisms, Inhibition and Reversal
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National

YEAR	ORGANIZATION	TITLE
1988	Dept. of Biological Chemistry California Inst. of Technology Pasadena, CA	Stabilization of Proteins during Freezing and Drying
1989	American Dairy Science Assc. Louisville, KY	Stabilization of Protein during Freezing and Drying
1990	Eastern Regional Center US Dept. of Agriculture Philadelphia, PA	Stabilization of Proteins during Freezing and Drying
1990	National Meeting of American Chemical Soc., Washington, DC	Applications of Infrared Spectroscopy to Protein-Stabilizer Interactions in Dried Solids
1991	Clinical Products Division Eastman Kodak, Rochester, NY	Stabilization of Proteins during Freezing and Drying
1991	Protein Biophysics Dept. Amgen, Thousand Oaks, CA	Stabilization of Proteins during Freezing and Drying
1992	Eli Lilly and Co. Indianapolis, IN	Stabilization of Proteins during Freezing and Drying
1992	Navy Medical R&D Command Office of Naval Research Washington, DC	AntifreezePeptide Enhances Cryopreservation of Human Red Blood Cells
1993	BioPharm Conference Cambridge, MA	Stabilization of Proteins during Freezing and Drying
1993	Baxter Diagnostics Miami, FL	Stabilization of Proteins during Freezing and Drying
1993	National Meeting of American Chemical Soc., Denver, CO	Stress Specific Protection of Proteins during Freeze-Drying

1993	Annual Meeting of American Assc. of Pharmaceutical Scientists, Orlando, FL	Stabilization of Proteins during Freezing and Drying
1993	Genentech, Inc. South San Francisco, CA	Stabilization of Proteins during Freezing and Drying
1993	Alza Corporation Palo Alto, CA	Stabilization of Proteins during Freezing and Drying
1994	National Meeting of American Chemical Soc., San Diego, CA	Infrared Spectroscopic Study of Lyophilization-induced Protein Aggregation
1994	Annual Meeting of American Assc. of Pharmaceutical Scientists, San Diego, CA	Applications of Infrared Spectroscopy to Stabilization of Proteins during Freeze Drying
1994	Zymogenetics, Inc. Seattle, WA	Applications of Infrared Spectroscopy to Stabilization of Proteins during Freeze Drying
1994	Immunex, Inc. Seattle, WA	Applications of Infrared Spectroscopy to Stabilization of Proteins during Freeze Drying
1995	R.W. Johnson Pharmaceutical Research Inst., Raritan, NJ	Applications of Infrared Spectroscopy to Stabilization of Proteins during Freeze Drying
1995	Annual Meeting of American Microbiol. Soc., Washington, DC	Stabilization of Proteins during Freezing and Drying
1995	Dept. of Industrial Pharmacy Purdue Univ., Lafayette, IN	Stabilization of Proteins during Freezing and Drying
1995	Dept. of Human Biochemistry and Genetics, Univ. of Texas Medical Branch, Galveston, TX	Stabilization of Proteins during Freezing and Drying
1996	Protein Formulation Department Alza Corporation Palo Alto, California	Stabilization of Proteins during Freezing and Drying
1996	Dept. of Pharmaceut. Sciences School of Pharmacy University of Michigan Ann Arbor, Michigan	Stabilization of Protein during Freezing and Drying
1996	Genencor International, Inc.	Stabilization of Proteins in Solution & during

	South San Francisco, CA	Freeze-Drying
1996	Amgen, Inc. Thousand Oaks, CA	Stabilization of Proteins during Freezing and Drying
1996	Biogen Cambridge, MA	Stabilization of Proteins during Freezing and Drying
1996	Inhale Therapeutics, Inc. Palo Alto, CA	Stabilization of Proteins during Freezing and Drying
1996	Dade International Miami, FL	Stabilization of Proteins in Solution & during Freeze-Drying
1996	Symposium on Alternative Career Paths, National Meeting of Amer. Assc. of Pharmaceutical Scientists, Seattle, WA	University of Colorado Program in Pharmaceut. Biotechnology: Diverse Career Paths of Co-Directors
1997	Dade International Miami, FL	Protein Stabilization during Freeze thawing
1997	Protein Stability in Drug Delivery Systems Short Course, AAPS National Meeting Boston, MA	Short- and Long-term Stabilities of Proteins in Aqueous Solution and Dried Solids
1997	Symposium on Graduate Education AAPS National Meeting, Boston	University of Colorado Center for Pharmaceutical Biotechnology
1998	Symposium on Protein Formulation Western Regional AAPS Meeting San Francisco, CA	Trehalose vs. Sucrose: Facts and Fantasies
1998	Pfizer, Inc., Groton, CT	Mechanisms for Success and Failure of Excipients as Protein Stabilizers
1998	Conference on Freeze-drying Pharmaceuticals & Biologicals Ascutney, VT	Mechanisms of Protein Stabilization by Surfactants
1998	Shortcourse on Formulations AAPS National Meeting San Francisco, CA	Rational Design of Stable Lyophilized Protein Formulations
1999	Genetics Institute, MA	Rational Design of Stable Lyophilized

		Protein Formulations
1999	DARPA Conference on Stabilization of Biomaterials Breckenridge, CO	Inhibition of Lyophilization-Induced Protein Unfolding
1999	Graduate Medical Program Univ. of Tennessee Knoxville	Thermodynamic Modulation of Amyloid Fibril Formation
1999	Amgen, Inc. Thousand Oaks, CA	Rational Design of Stable Lyophilized Protein Formulations
1999	Smith-Kline Beecham King of Prussia, PA	Rational Design of Stable Lyophilized Protein Formulations
1999	Amgen, Inc. Thousand Oaks, CA	Analysis of Solid-State Proteins with Infrared Spectroscopy
1999	Amgen, Inc. Thousand Oaks, CA	Stabilization of Proteins during Freezing
2000	Gordon Conference on Protein Assemblies, Ventura, CA	Thermodynamic Inhibition of Irreversible Protein Aggregation and Amyloid Fibril Formation
2000	Symposium on Osmolytes Experimental Biology, San Diego, CA	Thermodynamic Inhibition of Irreversible Protein Aggregation and Amyloid Fibril Formation
2001	IBC Conf. on Protein Formulation Plenary Lecture San Diego, CA	Rational Design of Stable Lyophilized Protein Formulations
2001	Higuchi Conference Lake Ozark, MO	Applications of Infrared Spectroscopy to Protein Formulation Development
2001	Novartis NJ	Rational Design of Stable Lyophilized Protein Formulations
2001	Becton Dickinson Technologies Research Triangle Park, NC	Rational Design of Stable Dried Protein Formulations
2001	Biogen Cambridge, MA	Rational Design of Stable Lyophilized Protein Formulations
2001	Biogen	Thermodynamic Inhibition of Irreversible



	Cambridge, MA	Protein Aggregation
2001	Dept. of Chemical Engineering Univ. of Michigan	Rational Design of Stable Lyophilized Protein Formulations
2002	Biogen Nonionic Cambridge, MA	Mechanisms of Protein Stabilization by Surfactants
2002	Wyeth Marietta, PA	Rational Design of Stable Lyophilized Protein Formulations
2002	Symposium on Biopreservation Annual Meeting of Society for Cryobiology, Breckenridge, CO	Rational Design of Stable Lyophilized Protein Formulations
2002	Biogen Cambridge, MA	Inhibition of Protein Aggregation in Aqueous Formulations
2002	Alza Palo Alto, CA	Rational Design of Stable Lyophilized Protein Formulations
2003	Eli Lilly Indianapolis, IN	Rational Design of Stable Lyophilized Protein Formulations
2003	MedImmune Mountain View, CA	High Pressure Disaggregation and Refolding of Proteins
2003	NIAID, NIH Rockville, MD	Rational Design of Stable Lyophilized Protein Formulations
2003	Human Genome Sciences Rockville, MD	Rational Design of Stable Lyophilized Protein Formulations
2003	Amgen Longmont, CO	Aggregation of Proteins in Aqueous Solution
2003	Orbus Ft. Lauderdale, FL	Rational Design of Stable Lyophilized Protein Formulations
2003	Eli Lilly Indianapolis, IN	Aggregation of Proteins in Aqueous Solution: Mechanisms, Inhibition and Reversal
2003	IBC Protein Formulation Conf. Philadelphia, PA	Rational Design of Stable Lyophilized Protein Formulations (Keynote Address)
2003	Amgen	Aggregation of Proteins in Aqueous Solutions:

	Thousand Oaks, CA	Mechanisms, Inhibition and Reversal
2003	Organ Recovery Systems Charleston, SC	Rational Design of Stable Lyophilized Protein Formulations
2003	Acambis Vaccines Cambridge, MA	Rational Design of Stable Lyophilized Protein Formulations
2003	Acambis Vaccines Cambridge, MA	Aggregation of Proteins in Aqueous Solutions: Mechanisms, Inhibition and Reversal
2004	Abbott Pharmaceuticals Chicago, IL	Aggregation of Proteins in Aqueous Solution: Mechanisms, Inhibition and Reversal
2004	Pfizer St. Louis, MO	Rational Design of Stable Lyophilized Protein Formulations
2004	IIR Protein Formulation Conf. San Francisco, CA	Aggregation of Proteins in Aqueous Solution: Mechanisms, Inhibition and Reversal
2004	Genentech San Francisco, CA	Aggregation of Proteins in Aqueous Solution: Mechanisms, Inhibition and Reversal
2004	IBC Early Devel. of Biopharm. Conf. San Diego, CA	Rational Design of Stable Lyophilized Protein Formulations
2004	Baxter Biosolutions Bloomington, IN	Rational Design of Stable Lyophilized Protein Formulations
2004	Protein Formulation Symposium Protein Society Annual Meeting San Diego, CA	Rational Design of Stable Lyophilized Protein Formulations
2004	Abbott Chicago, IL	Aggregation of Proteins: Formulation, Manufacturing and Regulatory Issues
2004	IBC Protein Formulation Conf. Boston, MA	Preservative-induced Protein Aggregation
2004	Genzyme Framingham, MA	Aggregation of Proteins in Aqueous Solution: Pathways, Inhibition and Reversal
2004	AstraZeneca Waltham, MA	Aggregation of Proteins in Aqueous Solution: Pathways, Inhibition and Reversal
2004	Protein Powder Symposium	Rational Design of Stable Dried Protein

AAPS National Meeting  
Baltimore, MD

Formulations

2004 IBC Well Characterized Biologicals Applications of Infrared Spectroscopy to  
Conf., Washington, DC Development of Stable Protein Formulations

International

YEAR	ORGANIZATION	TITLE
1990	CBER, FDA and International Assc. for Biol. Standardization Washington, DC	Stabilization of Proteins during Freezing and Drying
1991	Annual Meeting of Society for Cryobiology, Leuven, Belgium	Stabilization of Proteins during Freezing and Drying
1991	Annual Meeting of Society for Cryobiology, Leuven, Belgium	Antifreeze Peptide Enhances Cryopreservation of Human Red Blood Cells
1991	British Army Blood Depot Aldershot, England	Antifreeze Peptide Enhances Cryopreservation of Human Red Blood Cells
1992	Annual Meeting of the Society Cryobiology, Ithaca, NY	Theoretical Thermodynamic Basis for Cryoprotectant Toxicity
1992	Conference of Compatible Solutes and Macromolecular Stability Bodega Bay, CA	Stabilization of Proteins: Applications of Lessons from Nature
1992	Conference of Compatible Solutes and Macromolecular Stability Bodega Bay, CA	Effects of Antifreeze Peptide of Cryopreserved Human Red Blood Cells
1994	Colorado Protein Stability Conference, Breckenridge	Infrared Spectroscopic Studies of Lyophilization-induced Protein Aggregation
1995	American Chemical Society Conference on Formulations and Drug Delivery, Boston, MA	Thermodynamic Stabilization of Proteins during Freeze-drying and Storage in the Dried Solid
1995	109th International Meeting of the Association of Official Analytical Chemists	Stabilization of Proteins during Freezing and Drying
1996	IBC's 2nd International Conference	Stabilization of Proteins during Freezing and

	on Delivery of Proteins & Peptides, San Diego, CA	Drying
1996	Boehringer Mannheim Therapeutic Penzberg, Germany	Stabilization of Proteins during Freezing and Drying
1996	Boehringer Mannheim Therapeutic Penzberg, Germany	Specific Effects of Excipients on Protein Structure during Freezing and Drying
1996	Boehringer Mannheim Therapeutic Penzberg, Germany	Mechanisms of Protein Stabilization by Nonionic Surfactants
2002	Boehringer Ingleheim Germany	Rational Design of Stable Lyophilized Protein Formulations

***XII. GRANT/RESEARCH ACTIVITY***

*Proposals Funded:*

SBIR Phase I Grant, Office of Naval Research, 1989-1990, \$ 48,125

PI: John Carpenter

"Novel Cryopreservation Technique for Human Red Blood Cells using  
Recombinant Antifreeze Peptide"

Office of Naval Research, 1991-1994, \$ 837,500

PI: John Carpenter

"Cellular Damage during Non-Freezing Cold Injury"

SBIR Phase I Grant, NIH, 1991, \$ 50,000

Co-PI's: John Carpenter and Dr. Kelvin Brockbank

"Novel Cryopreservation Technique for Bone Marrow Cells using Antifreeze Peptide"

[REDACTED] 1993, \$ [REDACTED]

PI: John Carpenter

"Stabilization of Air-Dried Enzymes"

[REDACTED] 1993, \$ [REDACTED]

PI: John Carpenter

"Infrared Determination of Protein Structure During Freeze-Thawing"

[REDACTED] 1993-94, \$ [REDACTED]

PI: John Carpenter

"Application of Principles of Protein Stabilization to Surface-Adsorbed Antibodies"

Office of Naval Research, 1994-1996, \$419,484

PI: John Carpenter  
"Effects of Lyophilization of Metabolic Integrity of Red Blood Cells"

[REDACTED], 1994, \$ [REDACTED]  
Co-PI's: John Carpenter and Dr. [REDACTED]  
"Spectroscopic Studies on ANF-like Peptides"

[REDACTED] 1994, \$ [REDACTED]  
PI: John Carpenter  
"Effect of Lyophilization on Protein Structure"

[REDACTED] 1994-95, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"Stabilization of [REDACTED]"

[REDACTED], 1994-1995, \$ [REDACTED]  
Co-PI's: John Carpenter and Dr. [REDACTED]  
"Protein/polymer Phase Separation during Freezing and Drying"

[REDACTED], 1994-1996, \$ [REDACTED]  
PI: John Carpenter  
"Storage Stability of Protein Drugs"

[REDACTED], 1994-1995, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"Structural Basis for the Activity of [REDACTED]"

The Whitaker Foundation for Biomedical Engineering, 1995-1998, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"Stabilization of Hemoglobin by Polymers during Freezing, Drying and Rehydration:  
FTIR and EPR studies"

National Science Foundation, 1995-1998, \$400,000 plus \$850,000 in matching support  
from Eli Lilly, Merck, Genentech, Amgen, Immunex and Alza.  
Co-PI's: John Carpenter, Dr. Theodore Randolph and Dr. Jeffrey Cleland  
"Stabilization of Proteins by Polymers during Freezing, Drying and Rehydration:  
FTIR and EPR studies"

National Science Foundation, 1995-1998, \$400,000  
Co-PI's: Dr. Charles Glatz, Dr. Maurice Larson, Dr. Richard Honzatko,  
Dr. Theodore Randolph and John Carpenter  
"High Pressure Investigation of Protein Crystallization"

[REDACTED], 1995-1996, \$ [REDACTED]  
PI: John Carpenter  
"Development of Stable Lyophilized Formulations of [REDACTED] and [REDACTED]"

[REDACTED], 1995, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Studies of Protein Structure"

[REDACTED], 1995, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Studies of Protein Structure"

[REDACTED], 1995, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Analysis of Structure in Collagen Formulations"

[REDACTED], 1995, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Studies of Effects of Formulation and Storage Conditions on Structure of Spray-dried Proteins"

[REDACTED], 1995, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Analysis of Effects of Formulation on Structure of Freeze-Dried Proteins"

[REDACTED], 1995, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Analysis of Effects of Formulation on Structure of Freeze-Dried Proteins"

[REDACTED], 1995, \$ [REDACTED]

Co-PI's: John Carpenter and [REDACTED]  
"Structure and Activity of Human CRF"

[REDACTED], 1996-2000, \$ [REDACTED]

PI: John Carpenter  
"Effect of Excipients on Freezing- and Drying-Induced Denaturation of Protein Drugs"

[REDACTED], 1996-1997, \$ [REDACTED]

PI: John Carpenter  
"Effect of Excipients and Storage Conditions on Structure of Spray-dried Proteins"

[REDACTED], 1996-1997, \$ [REDACTED]

Co-PI's: John Carpenter and Dr. [REDACTED]  
"Stabilization of Proteins during Freezing and Drying"

[REDACTED], 1996-1997, \$ [REDACTED]

PI: John Carpenter  
"Optimizing Long-Term Storage Stability of Lyophilized [REDACTED] Formulations"

National Institutes of Health, SBIR Program, 1996, \$5,000 for JFC lab  
(Collaborator on grant by Dr. Kim Middleton of Cytoskeleton, Inc.)  
"Development of Products for Investigating the Cytoskeleton"

[REDACTED], 1996-1997, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"High Pressure Refolding of Inclusion Bodies"

[REDACTED], 1996-2000, \$ [REDACTED]  
PI: John Carpenter  
"Infrared Spectroscopic Investigation of Protein Structure in Drug Delivery Matrix"

[REDACTED], 1996-2003, \$ [REDACTED]  
Co-PIs: John Carpenter and [REDACTED]  
"Effects of Excipients on Liquid and Solid-State Stability of Subtilisin"

NATO Scientific Affairs Division, 1996-1997, \$6000 for international travel  
(Co-PI's: John Carpenter, Dr. A. Auffret and Dr. F. Franks, Pafra, Cambridge, UK)  
"Stabilization and Modification of Protein Structure by Vitrification"

[REDACTED] 1996, \$ [REDACTED]  
PI: John Carpenter  
"Infrared Spectroscopic Studies of Protein Structure in Therapeutic Formulations"

[REDACTED] 1996-1998, \$ [REDACTED]  
Co-PI's: John Carpenter and Dr. [REDACTED]  
"Mechanisms of Protein Stabilization by Nonionic Surfactants"

[REDACTED], 1997-1998, \$ [REDACTED]  
plus \$ [REDACTED] match in supplies and analysis  
Co-PI's: John Carpenter and [REDACTED]  
"Mechanisms of Protein Stabilization by Nonionic Surfactants"

[REDACTED], 1997-1998, \$ [REDACTED]  
PI: John Carpenter  
"Thermal and Infrared Spectroscopic Analyses of Lyophilized Formulations"

[REDACTED], 1997-1998, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"Stability of Human Serum Albumin during Processing"

[REDACTED], 1997-1998, \$ [REDACTED]

PI: John Carpenter  
"Infrared Spectroscopic Analysis of Lyophilized Protein Formulations"

[REDACTED], 1997, \$ [REDACTED]  
Co-PI's: John Carpenter and Dr. [REDACTED]  
"Exclusive Sponsorship of the Colorado Biopharmaceutical Delivery Conference"

[REDACTED] 1998-2005, \$ [REDACTED]  
Co-PI's: John F. Carpenter and Dr. [REDACTED]  
"Mechanisms for Protein Stabilization by Excipients"

National Science Foundation Merit Renewal, 1999-2001, \$400,000  
Co-PI's: John Carpenter and Dr. Ted Randolph  
"Mechanisms for Success and Failure of Excipients as Protein Stabilizers"

[REDACTED], 1999-2000, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"Production of Stable Protein Formulations in Fine Granules"

[REDACTED] 1999-2000, \$ [REDACTED]  
Co-PI's: Dr. [REDACTED] and John Carpenter  
"Production of Fine Powders of Protein Formulations with Super Critical Carbon Dioxide Assisted Spray-Drying"

[REDACTED] 2000-2001, \$ [REDACTED]  
Co-PI's: John Carpenter, [REDACTED] and [REDACTED]  
"Preparation of Stable Dry Powder Formulations of Live Attenuated Virus Vaccines"

[REDACTED] 2000-2001, \$ [REDACTED]  
Co-PI's: John Carpenter, [REDACTED], [REDACTED] and [REDACTED]uncan  
"Development of Stable Formulations of Antigen and Protein Adjuvant for Patch Transdermal Delivery Systems"

[REDACTED], 1999-2000, \$ [REDACTED]  
plus \$ [REDACTED] match in supplies and analysis  
PI: John Carpenter  
"Inhibition of Fibril Formation by Synucleins"

[REDACTED], 2000-2001, \$ [REDACTED]  
plus \$ [REDACTED] match in supplies and analysis  
Co-PI's: [REDACTED] and John Carpenter  
"High Pressure Refolding of Protein Aggregates"

[REDACTED] 2001-2002, \$ [REDACTED]  
Co-PI's: [REDACTED] and John Carpenter  
"High-Pressure Protein Disaggregation and Refolding"



DoD Multidisciplinary Research Program (DARPA), 2001-2006, \$5,490,556 (\$784,000 for UCHSC)

PI: Dr. Mehmet Toner, Harvard Medical School

Co-PI's: John Carpenter, David Pyatt, Steve Hand, Hagen Bayley

"Cellular Engineering for Suspended Animation"

NIH Training Grant, 2001-2006, \$900,000 plus \$600,000 matching from Univ. of Colorado

PI: Ted Randolph

Co-PI's: John Carpenter and Mark Manning

"Leadership Training in Pharmaceutical Biotechnology"

NIH, 2001-2004, \$160,000 for Carpenter lab

PI: Steve Schwendenman, Univ. of Michigan

Co-PI: John Carpenter

"Mechanisms for Protein Degradation and Stabilization in Microspheres"

Colorado Tobacco Research Fund, 2001-2004, \$ [REDACTED]

PI: [REDACTED]

Co-PI: John Carpenter

"Dried Powders of Therapeutic and Chemopreventive Compounds for Tobacco-Related Lung Diseases"

NSF, 2002-2005, \$431,000

Co-PI's: Ted Randolph and John Carpenter

"Physical and Chemical Stability of Therapeutic Proteins in Aqueous Solutions"

NIH, NIAID, 2003-2007, \$504,000

PI: John Carpenter (UCHSC component of multi-center project)

"Development of a Stable Heptavalent Botulism Vaccine"

[REDACTED], 2004-2005, \$ [REDACTED]

Co-PI's: John Carpenter and [REDACTED]

"Comparison of Different Drying Methods on Protein Structure and Stability"

[REDACTED], 2003-2004, \$ [REDACTED]

Co-PI's: John Carpenter and [REDACTED]

"Solubility, Opalescence, Crystallization and Aggregation of Aqueous Antibody Formulations"

[REDACTED], 2004-2005, \$ [REDACTED]

Co-PI's: John Carpenter and [REDACTED]

"Studies on [REDACTED]"

[REDACTED], 2003-2004, \$ [REDACTED]

Co-PI's: John Carpenter and [REDACTED]

“Effects of Metal Contaminants in Excipients on Oxidation of Biopharmaceuticals”

2004-2005, \$  
Co-PI's: John Carpenter and  
“Stable Lyophilized Vaccine Formulations”

2004-2005, \$  
Co-PI's: John Carpenter and  
“Aggregation of Monoclonal Antibodies”

*Proposals Pending*

### **XIII. PUBLICATIONS**

#### *A. Refereed Journals*

1. Hand, S.C. and J.F. Carpenter, 1986. pH-induced hysteretic properties of phosphofructokinase purified from rat myocardium. *Am. J. Physiol.* 250: R505-R511.
2. Carpenter, J.F. and S.C. Hand, 1986. Reversible dissociation and inactivation of phosphofructokinase in the ischemic rat heart. *Am. J. Physiol.* 250: R512-R518.
3. Carpenter, J.F. and S.C. Hand, 1986. Arrestment of carbohydrate metabolism during anaerobic dormancy and aerobic acidosis in *Artemia* embryos: Determination of pH-sensitive control points. *J. Comp. Physiol. B* 156: 451-459.
4. Hand, S.C. and J.F. Carpenter, 1986. pH-induced metabolic transitions in *Artemia* embryos mediated by a novel hysteretic trehalase. *Science* 232: 1535-1537.
5. Carpenter, J.F. and S.C. Hand, 1986. Comparison of pH-dependent allostery and dissociation for phosphofructokinases from *Artemia* embryos and rabbit muscle: Nature of the enzymes acylated with diethylpyrocarbonate. *Arch. Biochem. Biophys.* 248: 1-9.
6. Carpenter, J.F., S.C. Hand, L.M. Crowe, and J.H. Crowe, 1986. Cryoprotection of phosphofructokinase with organic solutes: Characterization of enhanced protection in the presence of divalent cations. *Arch. Biochem. Biophys.* 250: 505-512.
7. Carpenter, J.F., L.M. Crowe, and J.H. Crowe, 1987. Stabilization of phosphofructokinase with sugars during freeze-drying: characterization of enhanced protection in the presence of divalent cations. *Biochim. Biophys. Acta* 923: 109-115.
8. Anchordoguy, T.J., A.S. Rudolph, J.F. Carpenter, and J.H. Crowe, 1987. Modes of interaction of cryoprotectants with membrane phospholipids during freezing. *Cryobiology* 24: 324-331.
9. Carpenter, J.F., B. Martin, L.M. Crowe, and J.H. Crowe, 1987. Stabilization of phosphofructokinase during air-drying with sugars and sugar/transition metal mixtures. *Cryobiology* 24: 455-464.

10. Carpenter, J.F. and J.H. Crowe, 1988. The mechanism of cryoprotection of proteins by solutes. *Cryobiology* 25:244-255.
11. Carpenter, J.F., B. Martin, S.H. Loomis and J.H. Crowe, 1988. Long-term preservation of dried phosphofructokinase by sugars and sugar/zinc mixtures. *Cryobiology* 25: 372-376.
12. Carpenter, J.F. and J.H. Crowe, 1988. Modes of stabilization of a protein by organic solutes during desiccation. *Cryobiology* 25: 459-470.
13. Loomis, S.H., J.F. Carpenter and J.H. Crowe, 1988. Identification of strombine and taurine as cryoprotectants in the intertidal bivalve, *Mytilus edulis*. *Biochim. Biophys. Acta* 943:113-118.
14. Hazen, K.C., L.R. Dumensil and J.F. Carpenter, 1988. Cryoprotection of antibodies with organic solutes and organic solute/divalent cation mixtures. *Arch. Biochem. Biophys.* 15: 363-371.
15. Anchooguy, T.J., J.F. Carpenter, S.H. Loomis and J.H. Crowe, 1988. Mechanisms of interactions of amino acids with phospholipid membranes during freezing. *Biochim. Biophys. Acta* 946: 299-306.
16. Carpenter, J.F. and J.H. Crowe, 1989. Infrared spectroscopic studies on the interaction of carbohydrates with dried proteins. *Biochemistry* 28:3916-3922.
17. Loomis, S.H., J.F. Carpenter, T.J. Anchooguy, J.H. Crowe and B.R. Branchini, 1989. Cryoprotective capacity of end products of anaerobic metabolism. *J. Exp. Zool.* 252: 9-15.
18. Brockbank, K.G.M., T.J. Donovan, S.T. Ruby, J.F. Carpenter, P. -O. Hagan and M.A. Woodley, 1990. Functional analysis of cryopreserved veins: A preliminary report. *J. Vascular Surgery* 11:94-102.
19. Anchooguy, T.J., J.F. Carpenter, C.A. Cecchini, J.H. Crowe and L.M. Crowe, 1991. Effects of protein perturbants on phospholipid bilayers. *Arch. Biochem. Biophys.* 283:356-361.
20. Carpenter, J.F. and P.E. Dawson, 1991. Simple and rapid determination of dimethylsulfoxide with high performance liquid chromatography. *Cryobiology* 28: 210-215.
21. Brockbank, K.G.M., J.F. Carpenter, L.B. Schwartz, C. Nardiello and P.-O. Hagen, 1992. Smooth muscle function in short- and long-term stored cryopreserved veins. *Vascular Surgery* 26:116-122.
22. Brockbank, K.G.M., J.F. Carpenter and P. Dawson, 1992. Effect of storage temperature on viable bioprosthetic heart valves. *Cryobiology* 29:537-542.
23. Carpenter, J.F. and T.N. Hansen, 1992. Antifreeze protein modulates cell survival during cryopreservation: Mediation through influence on ice crystal growth. *Proc. Nat. Acad. Sci.* 89:8953-8957.
24. Anchooguy, T.J., J.F. Carpenter, C.A. Cecchini, J.H. Crowe and L.M. Crowe, 1992. Temperature dependent interactions of cryoprotectants with phospholipid bilayers. *Biochim. Biophys. Acta* 1104:117-

122.

25. Carpenter, J.F., S. Prestrelski and T. Arakawa, 1993. Separation of freezing- and drying-induced denaturation of lyophilized proteins by stress-specific stabilization: I. Enzyme activity and calorimetric studies. *Arch. Biochem. Biophys.* 303:456-464.

26. Prestrelski, S., T. Arakawa and J.F. Carpenter, 1993. Separation of freezing- and drying-induced denaturation of lyophilized proteins by stress-specific stabilization: II. Structural studies using infrared spectroscopy. *Arch. Biochem. Biophys.* 303:465-473.

27. Hansen, T.N. and J.F. Carpenter, 1993. Calorimetric determination of inhibition of ice crystal growth by antifreeze protein in hydroxyethyl starch solutions. *Biophysical J.* 64:1843-1850.

28. Prestrelski, S., N. Tedeschi, T. Arakawa and J.F. Carpenter, 1993. Dehydration-induced conformational changes in proteins and their inhibition by stabilizers. *Biophysical J.* 65: 661-671.

29. Vrkljan, M., T.M. Foster, M.E. Powers, J. Henkin, W.R. Porter, H. Staack, J.F. Carpenter and M.C. Manning, 1994. Thermal stability of low molecular weight urokinase during heat treatment. II. Effect of polymeric additives. *Pharm. Res.* 11:1004-1008.

30. Hansen, T.N. and J.F. Carpenter, 1994. The role of platelets in chilling-induced injury. *Ann. N.Y. Acad. Sci.* 714:279-281.

31. Dong, A., J. Matura, S.D. Allison, E. Chrisman, M.C. Manning and J.F. Carpenter, 1996. Infrared and circular dichroism spectroscopic characterization of structural differences between  $\beta$ -lactoglobulin genetic variants. *Biochemistry* 35:1450-1457.

32. Kendrick, B.S., A. Dong, S.D. Allison and J.F. Carpenter, 1996. Quantitation of area of overlap between second derivative amide I infrared spectra to determine structural similarity of a protein in different states. *J. Pharm. Sci.* 85:155-158.

33. Vrkljan, M., T.M. Foster, M.E. Powers, J. Henkin, W.R. Porter, H. Staack, J.F. Carpenter and M.C. Manning, 1996. Thermal stability of low molecular weight urokinase during heat treatment. III. Effect of salts, sugars and Tween 80. *Int. J. Pharm.* 134:193-201.

34. Chang, B.S., G. Reeder and J.F. Carpenter, 1996. Development of a stable freeze-dried formulation of recombinant human interleukin-1 receptor antagonist. *Pharm. Res.* 13:243- 249.

35. Chang, B.S., R.M. Beauvais and J.F. Carpenter, 1996 Physical factors affecting the storage stability of freeze-dried interleukin-1 receptor antagonist: Glass transition and protein conformation. *Arch. Biochem. Biophys.* 331:249-258.

36. Anchordoguy, T.J. and J.F. Carpenter, 1996. Polymers protect lactate dehydrogenase during freeze-drying by inhibiting dissociation in the frozen state. *Arch. Biochem. Biophys.* 332:231-238

37. Chao, H., P.L. Davies and J.F. Carpenter, 1996. Antifreeze protein-mediated cell survival during

cryopreservation correlates with thermal hysteresis activity. *J. Exp. Biol.* 199:2071-2076.

38. Allison, S.D., A. Dong and J.F. Carpenter, 1996. Counteracting effects of thiocyanate and sucrose on chymotrypsinogen secondary structure and aggregation during freezing, drying and rehydration. *Biophys. J.* 71:2022-2032.

39. Iztusu, K., S. Yoshioka, S. Kojima, T.W. Randolph and J.F. Carpenter, 1996. Effects of sugars and polymers on crystallization of poly(ethylene glycol) in frozen solutions: Phase separation between incompatible polymers. *Pharm. Res.* 13:1393-1400.

40. Dong, A., J.D. Meyer, B.S. Kendrick, M.C. Manning and J.F. Carpenter, 1996. Effect of secondary structure on the activity of enzymes suspended in organic solvents *Arch. Biochem. Biophys.* 334:406-414.

41. Heller, M., J.F. Carpenter and T.W. Randolph, 1996. Effect of phase separating systems on lyophilized hemoglobin. *J. Pharm. Sci.* 85:1358-1362.

42. Chang, B.S., B.S. Kendrick and J.F. Carpenter, 1996. Surface-induced denaturation of proteins during freezing and its inhibition by surfactants. *J. Pharm. Sci.* 85:1325-1330.

43. Chang, B.S., R.M. Beauvais, T. Arakawa, L.O. Narhi, A. Dong, D.I. Aparisio and J.F. Carpenter. 1996. Formation of an active dimer during storage of interleukin-1 receptor antagonist in aqueous solution. *Biophys. J.* 71:3399-3406.

44. Griffin, K., J., T.M. Dwyer, M.C. Manning, J.D. Meyer, J.F. Carpenter and F.E. Frerman, 1997. Investigation of the T244M mutation in the alpha subunit of *Paracoccus denitrificans* electron transfer flavoprotein *Biochemistry* 36:4192-4202.

45. Stratton, L., A. Dong, M.C. Manning and J.F. Carpenter, 1997. Drug delivery matrix containing native protein precipitates suspended in a poloxamer gel. *J. Pharm. Sci.* 86:1007-1010.

46. Dong, A., V. Kery, J. Matsuura, M.C. Manning, J.P. Kraus and J.F. Carpenter, 1997. Secondary structure of human cystathionine  $\beta$ -synthase in aqueous solution: Effect of ligand binding and proteolytic truncation. *Arch. Biochem. Biophys.* 344:125-132.

47. Dong, A., L. Kreilgard, B.S. Kendrick, J. Matsuura, M.C. Manning and J.F. Carpenter, 1997. Secondary structure and thermal stability of recombinant human Factor XIII in aqueous solution. *Arch. Biochem. Biophys.* 347:213-220.

48. Kendrick, B.S., J.D. Meyer, J.E. Matsuura, J.F. Carpenter and M.C. Manning, 1997. Hydrophobic ion pairing as a method for enhancing structure and activity of lyophilized enzymes suspended in organic solvent. *Arch. Biochem. Biophys.* 347:113-118.

49. Remmele, R., C. Stushnoff and J.F. Carpenter, 1997. Real-time infrared spectroscopic examination of protection of protein structure by sucrose during freezing and drying. *Pharm. Res.* 14:1548-1555.

50. Heller, M.C., J.F. Carpenter and T.W. Randolph, 1997. Manipulation of lyophilization-induced phase separation: Implications for pharmaceutical proteins. *Biotechnology Progress* 13:590-596.
51. Kendrick, B.S., B.S. Chang, T. Arakawa, B. Peterson, T.W. Randolph, M.C. Manning and J.F. Carpenter, 1997. Preferential exclusion of sucrose from recombinant interleukin-1 receptor antagonist: Role in restricted conformational mobility and compaction of native state. *Proc. Nat. Acad. Sci.* 94:11917-11922.
52. Anchordoquy, T.J., J.F. Carpenter and D.J. Kroll, 1997. Maintenance of transfection rates and physical characterization of lipid/DNA complexes after freeze-drying and rehydration. *Arch. Biochem. Biophys.* 348:199-206.
53. Izutsu, K., M.C. Heller, T.W. Randolph and J.F. Carpenter, 1998. Effect of salts and sugars on phase separation of frozen aqueous polyvinylpyrrolidone (PVP)-dextran solutions induced by freeze-concentration. *J. Chem. Soc. Faraday Trans.* 94:411-417.
54. Dong, A., J. Matsuura, M.C. Manning and J.F. Carpenter, 1998. Intermolecular  $\beta$ -sheet results from trifluoroethanol-induced  $\alpha$ -helical structure in  $\beta$ -sheet predominant proteins: Infrared and circular dichroism spectroscopic study. *Arch. Biochem. Biophys.* 355:275-281.
55. Kendrick, B.S., T.W. Randolph, J. Cleland, X. Lam, T. Nguyen, M.C. Manning and J.F. Carpenter, 1998. Aggregation of recombinant human interferon-gamma: Kinetics and structural transitions *J. Pharm. Sci.* 87:1069-1080.
56. Anchordoquy, T.J., L.G. Girouard, J.F. Carpenter and D.K. Kroll, 1998. Stability of lipid/DNA complexes during agitation and freeze-thawing. *J. Pharm. Sci.* 87:1046-1051.
57. Kreilgaard, L., L. Jones, T.W. Randolph, S. Frokjaer, J. Flink, M.C. Manning and J.F. Carpenter, 1998. Effects of Tween 20 on agitation- and freeze-thawing-induced aggregation of recombinant Factor XIII *J. Pharm. Sci.* 87:1597-1603.
58. Kendrick, B.S., J.F. Carpenter, J. Cleland and T.W. Randolph, 1998. A transient expansion of the native state precedes aggregation of recombinant human interferon-gamma. *Proc. Nat. Acad. Sci.* 95:14142-14146.
59. Allison, S.D., T.W. Randolph, A. Davis, K. Middleton and J.F. Carpenter, 1998. Effects of drying methods and additives on structure and function of actin: Mechanisms of dehydration-induced damage and its inhibition. *Arch. Biochem. Biophys.* 358:171-181.
60. Ning, L., B.S. Kendrick, M.C. Manning, J.F. Carpenter and J.G. Duman, 1998. Secondary structure of antifreeze proteins from overwintering larvae of the beetle *Dendroides canadensis*. *Arch. Biochem. Biophys.* 360:25-32.
61. Bam, N., J.L. Cleland, M.C. Manning, J.F. Carpenter, R. Kelly and T.W. Randolph, 1998. Tween protects recombinant human growth hormone against agitation-induced damage via hydrophobic

interactions. *J. Pharm. Sci.* 87:1554-1559.

62. Kreilgaard, L., S. Frokjaer, J.M. Flink, T.W. Randolph and J.F. Carpenter, 1998. Effects of additives on the stability of recombinant human Factor XIII during freeze-drying and storage in the dried solid. *Arch. Biochem. Biophys.* 360:121-134.

63. Heller, M.C., J.F. Carpenter and T.W. Randolph, 1999. Applications of a thermodynamic model to the prediction of phase separation of freeze concentrated formulations for protein lyophilization. *Arch. Biochem. Biophys.* 363:191-201.

64. Heller, M.C., J.F. Carpenter and T.W. Randolph, 1999. Protein formulation and lyophilization cycle design: Prevention of damage due to freeze-concentration induced phase separation. *Biotech. Bioengin.* 63:166-174.

65. Heller, M.C., J.F. Carpenter and T.W. Randolph, 1999. Conformational stability of lyophilized PEGylated proteins in a phase separating system. *J. Pharm. Sci.* 88:58-64.

66. Yang, T.-H., A. Dong, J. Meyer, O.L. Johnson, J.L. Cleland and J.F. Carpenter, 1999. Use of infrared spectroscopy to assess secondary structure of human growth hormone within biodegradable microspheres. *J. Pharm. Sci.* 88:161-165.

67. Kreilgaard, L., S. Frokjaer, J.M. Flink, T.W. Randolph and J.F. Carpenter, 1999. Effects of additives on the stability of *Humicola lanuginosa* lipase during freeze-drying and storage in the dried solid. *J. Pharm. Sci.* 88:281-290

68. Allison, S.D., T.W. Randolph, B. Chang and J.F. Carpenter, 1999. Hydrogen bonding between sugar and protein is responsible for inhibiting dehydration-induced protein unfolding. *Arch. Biochem. Biophys.* 365:289-298.

69. Webb, J.N., R.Y. Waghmare, J.F. Carpenter, C.E. Glatz and T.W. Randolph, 1999. Pressure effect on subtilisin crystallization and solubility. *J. Crystal Growth* 205:563-574.

70. St. John, R.J., J.F. Carpenter and T.W. Randolph, 1999. High pressure fosters protein refolding from aggregates at high concentrations. *Proc. Nat. Acad. Sci. USA* 96:13029-13033.

71. Webb, J.N., J.F. Carpenter and T.W. Randolph, 2000. Stability of subtilisin and lysozyme under high hydrostatic pressure. *Biotechnology Progress* 16:630-636.

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*B. Invited Review Articles (Refereed)*

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#### *F. Patents/Patent Applications*

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