

**Patrick S. Daugherty, Ph.D.**  
**Department of Chemical Engineering**  
**University of California, Santa Barbara, CA, 93106**  
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## **Education**

1999 Ph.D. Chemical Engineering, The University of Texas at Austin  
1993 B.S. Chemical Engineering (with Honors), University of Minnesota,  
Minneapolis-St. Paul

## **Appointments**

07/01-present Assistant Professor, Department of Chemical Engineering  
07/02-present Assistant Professor, Biomolecular Science and Engineering  
07/05-present Co-founder, and Scientific Advisory Board, CytomX, LLC  
01/04-present Affiliate Member, California Nanosystems Institute (CNSI)  
03/03-present Team Leader, Institute for Collaborative Biotechnologies  
05/99-07/01 Postdoctoral Research Fellow, Fred Hutchinson Cancer Center (Seattle, WA)  
08/98-01/99 Visiting Engineer, SRI International (Menlo Park, CA)  
09/93-04/99 Research Assistant, Chemical Engineering, University of Texas at Austin

## **Awards and Honors**

2006 Camille Dreyfus Teacher Scholar Award  
2005 National Science Foundation CAREER Award  
2005 Best Poster, AIChE National Meeting, Division 15, (to M. Mena)  
2005 Keynote Lecturer, FOSBE Meeting  
2004 Best Poster Award, ICB-Industry Conference, (to S. Hu, & P. Bessette)  
2003 Santa Barbara Cottage Hospital Research Award  
1999 NIH Virology-Oncology Fellow, FHCRC  
1997 Biotechnology Training Fellow, UT-Austin  
1993 3M Scholar, University of Minnesota

## **Professional Service**

2006- Consultant, CytomX, LLC.  
2006 Session Organizer and Chair, SBE Meeting, Biomolecular Engineering  
2006 Session Organizer and Chair, ACS Meeting  
2006 Visiting Committee Panel Member, NIH-NCRR  
2005 Session Chair, ACS Meeting  
2004-05 Consultant, Applied BioSystems, Applera Corp.  
2004 Study Section Member, Microbial Detection, NIH  
2004 Review Panel Member, Biosensors, National Science Foundation

## Publications

Average number of citations per paper = 46

\* Designates corresponding author(s)

1. Georgiou, G. \*, Stathopoulos, C., Daugherty, P.S., Nayak, A.R., Iverson, B.L., and Curtiss III, R. \* (1997) Display of Heterologous Proteins on the Surface of Microorganisms: From The Screening Of Combinatorial Libraries to Live Recombinant Vaccines. *Nature Biotechnology*, 15, 29-34.
2. Daugherty, P.S., Chen, G., Olsen, M.J., Iverson, B.L. \*, and Georgiou, G. \* (1998) Antibody Affinity Maturation Using Bacterial Surface Display, *Protein Engineering*, 11, 825-32.
3. Daugherty, P.S., Olsen, M.J., Iverson, B.L. \*, and Georgiou, G. \* (1999) Development of an Optimized Expression System for the Screening of Antibody Libraries Displayed on the *E.coli* Surface. *Protein Engineering*, 12, 613-621.
4. Daugherty, P.S., Chen, G., Iverson, B.L. \*, and Georgiou, G. \* (2000) Quantitative Analysis of The Effect of Mutation Frequency on the Affinity Maturation of Single Chain Fv Antibodies. *Proc. Nat. Acad. Sci. U S A*, 97:2029-2034.
5. Olsen, M.J., Stephens, D.L., Griffiths, D., Daugherty, P.S., Georgiou, G. \*, and Iverson, B.L.\* (2000) Function-Based Isolation of Novel Enzymes from a Large Library, *Nature Biotechnology*, 18, 1071-1074.
6. Daugherty, P.S. \*, Iverson, B.L., and Georgiou, G. (2000) Flow Cytometric Screening of Cell-Based Libraries, *J. Immunol. Methods*, 243, 211-227.
7. Daugherty, P.S. \* (2002) Cell Surface Display And Cytometric Screening for Protein Ligand Isolation and Engineering In: Vector Targeting for Therapeutic Gene Delivery, *Wiley Press*.
8. Bessette, P.H., Nguyen, A.W., Mena, M. A., Daugherty, P.S. \* (2003) Construction of Designed Combinatorial Libraries Using Gene Assembly Mutagenesis. *Meth. Mol. Biol*, Humana Press, v. 231, 29-38.
9. Nguyen, A. W., Daugherty, P.S. \* (2003) Production of Randomly Mutated Plasmid Libraries Using Mutator Strains *Meth. Mol. Biol*, Humana Press. v. 231, 39-43.
10. Bessette, P.H., Daugherty, P.S. \* (2004) Flow Cytometric Cloning of Fluorescent Proteins from cDNA Expression Libraries, *Biotechnology Progress*, 20, 963-967.
11. Bessette, P.H., Rice, J. Daugherty, P.S. \* (2004) Rapid Isolation of High Affinity Protein Binding Peptides Using Bacterial Display, *Protein Engineering, Design & Selection*, 17(10):731-9.
12. Nguyen, A.W. Daugherty, P.S. \* (2005) Evolutionary Optimization of Fluorescent Proteins for Intracellular FRET, *Nature Biotechnology*, 23(3):355-60.

*Commentary: "FRET - Feat," Nature Biotechnology Online, March 2005.*

*Commentary: "FRET Not Evolution," Taroncher-Oldenburg, G., Nature Biotechnology, March, 2005, 23, 3, p viii.*

13. Mena, M.A., Daugherty P.S.\* (2005) Computational Design of Degenerate Codon Libraries, *Protein Engineering, Design & Selection*, 18(12):559-61.
14. Hu, X. Bessette, P.H., Qian, J. Meinhart, C.D., Daugherty, P.S.\* , Soh, H.T.\* (2005) Marker Specific Sorting of Rare Cells Using Dielectrophoresis, *Proc. Natl. Acad. Sci. U S A*, 102(44) 15757-15761.

*Commentary: "Playing the Field," Eisenstein, M., Nature, 441, June, 2006, p1181.*

*Commentary: "Sorting Rare Cells," Analytical Chemistry, January, 2006, p.3*

15. Dane, K.Y., Chan, L., Rice, J.R., Daugherty, P.S.\* (2006) Isolation of Cell Specific Peptide Ligands using Fluorescent Bacterial Display Libraries, *J. Immunol. Methods*, 309(1-2):120-9.
16. Curnow, P. Bessette, P.H., Kisalilus, D. Murr, M.M., Daugherty, P.S. Morse, D.E.\* (2005) *JACS*, Enzymatic Synthesis of Layered Titanium Phosphates at Low Temperature and Neutral pH by Cell-Surface Display of Silicatein- $\alpha$ . *J. Am. Chem. Soc.*, 127(45):15749-55.
17. Rice, J.J., Schohn, A., Bessette, P.H., Boulware, K.T., Daugherty, P.S.\* (2006) Bacterial Display Using Circularly Permuted Outer Membrane Protein OmpX Yields High Affinity Peptide Ligands, *Protein Science*, 10(3), 825-36.

*News Article: "Developing Sophisticated Protein-Based Drugs," K. John Morrow, Genetic Engineering News, 25,13, p1.*

18. Boulware, K.T. Daugherty, P.S.\* (2006) Protease Specificity Determination Using Cellular Libraries of Peptide Substrates (CLiPS), *Proc. Natl. Acad. Sci. U S A*, 103(20), 7583-88.

*Commentary: "Clipping Away at Protease Substrates," DeFrancesco, L., Nature Biotechnology, June, 2006, 24, 6, p665.*

*Commentary: "Sorting out the Best Targets," Eisenstein, M., Nature Methods, July, 2006, 3, 7, p498.*

Best Poster, AIChE National Meeting (2006), Division 15, (to K. Boulware)

19. Nguyen, A.W., You, X. Jabaiah, A.M., Daugherty, P.S.\* (2006) Fluorescent Protein FRET Applications: Protein Engineering, Intracellular Sensing, and Interaction Screening, *Principles of Fluorescence Spectroscopy, Fluorescent Proteins and Their Uses*. Vol. 12; In Press.
20. Dane, K.Y., Zhu, Y. Nguyen, A.W., Daugherty, P.S.\* (2006) Detection of Caspase-3 Activity using Intracellular Fluorescent Protein FRET," *Meth. Mol. Biol.* Humana Press, In Press

21. Oh, S.H., Kenrick, S., Daugherty, P.S., Soh, H.T. \* (2006) Microfluidic Protein Detection Using Genetically Engineered Bacteria. *J. Proteome Res.*, doi: 10.1021/pr060193a.
22. Mena, M.A., Treynor, T. Mayo, S.L. Daugherty, P.S. \* (2006) Blue Fluorescent Proteins with Enhanced Brightness and Photostability from a Structurally Targeted Library, *Nature Biotechnology*, 24(12): doi: 10.1038/nbt1264.
23. You, X. Nguyen, A.W., Jabaiah, A., Sheff, M.A., Thorn, K.S., Daugherty, P.S. \* (2006) Intracellular Protein Interaction Mapping with FRET Hybrids,” *Proc. Natl. Acad. Sci. U S A*, 103 (48).
24. Bessette, P.H., Hu, X., Soh, H.T. \*, Daugherty, P.S. \* (2006) Microfluidic Library Screening for Mapping Antibody Epitopes. *Analytical Chemistry*, In Press.

## Patents

1. B.L. Iverson, G. Georgiou, M.J. Olsen, G. Chen, Daugherty, P.S. (1997) Directed Evolution of Antibodies and Enzymes, U.S. Application: 09/782,672.  
\* Licensed to Maxygen, Inc. (Redwood City, CA, NASDAQ: MAXY)
2. Daugherty, P.S., Bessette, P.H., Rice, J.J. (2004) Reagents and Methodologies for Bacterial Cell Surface Display, Patent Pending.  
\* Licensed to Applied Biosystems (Foster City, CA, NYSE:ABI), and CytomX, LLC. (Goleta, CA)
3. Daugherty, P.S., Nguyen, A.W. (2005) FRET Assays Using Fluorescent Proteins, Patent Pending.  
\* Reagents requested by and distributed to more than 250 research groups worldwide since March, 2005.
4. Oh, Sang-Hyun, Kenrick, S. Daugherty, P. Soh. T. (2005) Methodology for Scalable Protein-Detection, Patent Pending.
5. Daugherty, P.S. , Boulware, K., (2006) Cell Surface Display Methodology for Determination of Enzyme Specificity and Activity, Patent Pending.  
\* Licensed to CytomX, LLC. (Goleta, CA)

## Courses Taught (UC- Santa Barbara)

ChE 132A Analytical Methods in Chemical Engineering  
 ChE 171 Introduction to Biochemical Engineering  
 BMSE 251 Introduction to Biopharmaceutical Engineering  
 ChE 180A, B Undergraduate Chemical Engineering Laboratory

### **Post-Doctoral Students Supervised (5 Total)**

Paul H. Bessette, Ph.D.  
Sang-Hyun Oh, Ph.D.  
Sangho Lee, Ph.D.  
Claudia Gottstein, M.D.  
Yimin Zhu, M.D., Ph.D.

### **Doctoral Students Supervised (10 Total)**

Annalee W. Nguyen, (Ph.D. awarded 2006)  
Marco A. Mena  
Kevin T. Boulware  
Jeffrey J. Rice  
Karen Dane  
Sejal Sempat  
Xia You  
Sophia Kenrick  
Jerry Thomas  
Abeer Jabaiah

### **Undergraduate Students Supervised in Research (14 Total)**

Athra Kaviani, Yu-Anne Chen, David Lee, Laura-Marie Nucho, Abeer Jabaii, Kristy Troung, Aaron Schohn, Lisa A. Chan, Melanie Matheu, Ulrich Wuellner, Monica Lozano, Heather Hultgen, Sean Beal, Victor Morales

### **Teaching Contributions**

- Developed and taught new Freshmen Seminar entitled 'Biotechnology Controversies'.
- Successfully secured external funding for, and developed new laboratory experiment for undergraduate laboratory; 'Fluorescent Fermentations'.
- Developed and taught new graduate level course (BMSE 251) entitled, "Introduction to Biopharmaceutical Engineering," attended by chemistry, engineering, and biology students.
- Co-developed and taught a new 4 credit Chemical Engineering math course ChE132A, which integrates computer math tools with analytic approaches.
- Participated in curriculum revision workshop for the discipline of Chemical Engineering as part of the National 'Frontiers of Chemical Engineering' organized by Robert Armstrong (MIT).

### **Selected Invited Presentations**

1. Rapid Molecular Recognition Element Isolation Using Bacterial Display Peptide Libraries, UCSB MROP Presentation, January 2002
2. Evolution of the Efficiency of FRET in Fluorescent Proteins, University of California, Santa Barbara, Chemistry, March, 2003.

3. Accelerating Affinity Reagent Development, BD Biosciences, San Jose, CA, April, 2003.
4. Molecular Recognition in High Gear: Bacterial Display, Genencor International, San Francisco, CA, July, 2004.
5. New Strategies for Therapeutic Protein Engineering, Neuroscience Research Institute, UCSB, March, 2004.
6. The FACS on Molecular Recognition: Bacterial Display Peptide Libraries, Lawrence Livermore National Labs, Bio-Security Group, April, 2004.
7. Biotechnology Tools for Discovery and Synthesis, Army Research Labs, Natick Soldier Center, & USAMRIID, Ft. Detrick, August, 2004.
8. The FACS on Bacterial Display: Engineering Molecular Recognition, Bioprocess Technology Institute, University of Minnesota, Minneapolis, MN, September, 2004.
9. The FACS on Biomolecular Recognition: Bacterial Display Peptide Libraries, USAMRIID, Fort Detrick, MD, September, 2004.
10. Accelerating Affinity Reagent Development Using Bacterial Display Peptide Libraries, Applied BioSystems, Santa Clara, CA, October, 2004.
11. Bacterial Display Process Development for Peptide Affinity Reagent Production, American Society for Microbiology, San Diego, CA, November, 2004.
12. Display Library Screening-on-a-Chip, Phage Display Meeting, Cambridge, MA, May 2005.
13. New Proteomics Tools for Systems Biology, FOSBE Meeting, Santa Barbara, CA, August, 2005.
14. Exploiting Molecular Specificity for Biopharmaceutical Development, Johns Hopkins University, October, 2005.
15. Exploiting Molecular Specificity for Biopharmaceutical Development, University of Texas at Austin, November, 2005.
16. Novel Routes to Peptide Therapeutics, Northwestern University, April 2006.
17. Robust Display Technology for Peptide Ligand Engineering, ICB - Industry Conference, UCSB, May, 2006.
18. Improvement of Tumor Targeting Specificity with Protein Engineering, CCNE – Educational Meeting, Burnham Research Institute, San Diego, CA, June, 2006.
19. Design and Assembly of Protein Therapeutics, Columbia University, New York, NY, Oct. 2006.
20. Assembly of Responsive Protein Therapeutics, MCDB Department, UCSB, October, 2006.

### **Selected Contributed Presentations**

1. Bacterial Display Peptide Libraries, ECI Biochemical Engineering Meeting, Boulder, CO, July 2003.
2. Rapid Isolation of High Affinity Protein-Binding Peptides Using Bacterial Display, ACS National Meeting, Anaheim, CA, March, 2004.
3. Bacterial Display Peptide Libraries From Targets to Affinity Reagents in 24 Hours, World Congress on Biotechnology, Santiago, Chile, October, 2004.

4. Accelerating Affinity Reagent Development with Bacterial Display Peptide Libraries, AIChE National Meeting, Austin, TX, November, 2004.
5. Protease Isolation and Evolution in the Intracellular Environment, ACS National Meeting, San Diego, CA, March, 2005.
6. High-Throughput Protease Screening Using Optimized Fluorescent Protein FRET, ECI Biochemical Engineering Meeting, XIV, July, 2005.
7. High-Throughput Protease Screening Using Optimized Fluorescent Protein FRET, Protein Society Meeting, San Diego, CA, August, 2005.
8. N-Terminal Bacterial Display Peptide Libraries, Protein Society Meeting, San Diego, CA August, 2005.
9. Blue Fluorescent Proteins from a Computationally Designed Library, Protein Society Meeting, San Diego, CA, August, 2005.
10. Bacterial Substrate Display for Characterizing Protease Specificity, Protein Society Meeting, San Diego, CA, August, 2005.
11. Engineering of High Affinity Binding Peptides Using N-Terminal Bacterial Display, AIChE National Meeting, Cincinnati, OH, November, 2005.
12. Isolation of Tumor Targeting Peptides Using Fluorescent Bacterial Display Libraries, AIChE National Meeting, Cincinnati, OH, November, 2005.
13. Cell-Linked Peptide Substrates (CLiPS): A New Method for Proteolytic Enzyme Characterization, AIChE National Meeting, Cincinnati, OH, November, 2005.
14. Enhanced Blue Fluorescent Proteins Using Computational Design and Library Screening, AIChE National Meeting, Cincinnati, OH, November, 2005.
15. Optimized Fluorescent Protein FRET for Intracellular Protease Detection, Fluorescent Proteins, San Diego, CA, November, 2005.
16. Evolving Display Technology to Efficiently Search Sequence Space, Pacifichem, Honolulu, HI, December, 2005.
17. Protease Specificity Profiling with the CLiPS System, Gordon Conference on Proteases, NH, July, 2005.
18. New strategies for engineering the Properties of Peptides as Therapeutics, ACS National Meeting, San Francisco, CA, Sept, 2006.

## University Service

2001-02	Department of Chemical Engineering, Undergraduate Student Affairs Committee
2001-02	Department of Chemical Engineering, Web Committee
2001-02	College of Engineering, Bioengineering Seminar Committee
2002	Organized and Hosted Chemical Engineering Department 290 Seminar
2002-present	College of Engineering, Bioengineering Seminar Committee
2002-present	Department of Chemical Engineering, Graduate Affairs Committee
2002-04	College of Engineering Executive Committee
2003-present	ARO Institute for Collaborative Biotechnologies Grant, Co-PI
2003	Development of freshman seminar: 'Biotechnology News and Views'
2003	BMSE Chair Search Committee
2003-05	Led Successful Proposal for Major Shared Research Instrumentation

2003-04 Advisory Committee, Biomolecular Science and Engineering  
 2003 Cancer Research Distinguished Seminar Committee  
 2003 Biological Systems Engineering Chair Search Committee  
 2003-04 Faculty Search Committee, Department of Chemical Engineering  
 2003-present Neuroscience Research Institute Advisory Committee  
 2003-present Chair, Cell Sorting Shared Facility  
 2003-present Institute for Collaborative Biotechnologies, Executive Committee, Member  
 2003-present Institute for Collaborative Biotechnologies, Team Leader  
 2004-05 Chair, Faculty Search Committee, Department of Chemical Engineering  
 (two appointments made)  
 2004-05 Undergraduate Curriculum Committee, Chemical Engineering  
 2005-06 Graduate Student Recruiting Committee  
 2005-06 Chair, Ph.D. Exam Kinetics Committee  
 2005-06 Led Successful Proposal for Biosensor Instrumentation (SPR), Lead PI  
 2005-06 Co-authored Successful Dreyfus Proposal for ChE Undergraduate Laboratory  
 2006-present Bionanofabrication Lab Design Committee, California Nanosystems Institute

### Refereeing Activity:

Journal Referee (2001-present)

*JACS, Protein Engineering, Design & Selection, J. Mol. Biol., J. Biotechnology, Biotechnology & Bioengineering, J. Mol. Recognition, Journal of Applied Biochem & Biotechnology, Journal of Immunological Methods, Biochemistry, Biotechnology Progress*

Proposal Referee (2001-present)

*National Institutes of Health (NIBIB, NCRR), National Science Foundation (BES), California BioStar program, US Department of Energy, US Department of Defense, US Army Research Office*

### Grants and Contracts

(Amounts listed are direct costs (DC) to P. S. Daugherty)

Years	Source/Mechanism	Project Title	\$ Amt. (DC)	PI
2002-03	UC-Cancer Research Coordinating Committee	Development of an Economical, High-throughput Screen for Antibodies That Induce Tumor-Cell Specific Apoptosis	\$50,000	Daugherty, P.
2002-07	NIH - NIBIB (RO1)	Combinatorial Optimization of Protein Biosensors	\$750,000	Daugherty, P.
2002-03	Cottage Hospital	Enzyme Engineering for Alzheimer's Beta Peptide Degradation	\$25,000	Daugherty, P.
2003-05	UCTSRTP	Degradation of an Organophosphate Pesticide	\$50,000	Daugherty, P.



2004-05	NIH - NCRR (S10)	Establishment of a Shared Cell Sorting Facility at UCSB: FACSAria™ High Speed Cell Sorter	\$430,000	Daugherty, P.
2003-08	ARO-ICB	New Scaffolds for Engineering Peptide Ligands	\$380,000	Daugherty, P.
2003-04	Genencor Intl. Inc.	Optimized Ligand Selection and Engineering	\$20,000	Daugherty, P.
2004	UCSB Academic Senate	Academic Senate New Grant Award	\$5,000	Daugherty, P.
2004-06	NIH-NCI (R21)	(R21) Bacterial Display Methodologies for Tumor Targeting	\$228,000	Daugherty, P.
2005-06	Army Research Office	Rapid Fingerprinting of Pathogens	\$170,000	Daugherty, P.
2005-10	NIH - NHLBI (U01)	Nanotherapy for Vulnerable Plaque: Program of Excellence in Nanotechnology	\$450,000 (DC to PSD)	Smith, J.
2005-10	NSF-BES (CAREER)	CAREER: Specificity in Complex Biomolecular Systems	\$325,000	Daugherty, P.
2005-10	NIH - NCI (U54)	Center of Cancer Nanotechnology Excellence: Project 1 (PSD is Project Co-PI with E. Rouslahti)	\$330,000 (DC to PSD)	Esener, S.
2005-10	NIH - NCI (U54)	Center of Cancer Nanotechnology Excellence: Project 3 (PSD is Project Co-PI with R. Tsien)	\$917,000 (DC to PSD)	Esener, S.
2006-07	Army Research Office (DURIP)	Biomolecular Interaction Analysis	\$308,000	Daugherty, P.
2006-11	Dreyfus Foundation	Camille Dreyfus Teacher Scholar Award	\$75,000	Daugherty, P.