ANNE SKAJA ROBINSON

Chair of Chemical and Biomolecular Engineering
Catherine and Henry Boh Professor in Engineering
Tulane University, 300 Lindy Boggs Laboratory
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EDUCATION

1994 **Ph.D., Chemical Engineering** University of Illinois at Urbana-Champaign
Dissertation: *"Engineering the Yeast Secretory Pathway: The role of BiP and PDI in the secretion of foreign proteins in* Saccharomyces cerevisiae."
Advisors: *Prof. Douglas A. Lauffenburger, Prof. K. Dane Wittrup*

1989 **M.S., Chemical Engineering** The Johns Hopkins University
Thesis: *"Isolation and Characterization of Proteolytic Enzymes from the Hyperthermophilic Archaebacterium* Pyrococcus furiosus."
Advisor: *Prof. Robert M. Kelly*

1988 **B.S., Chemical Engineering** The Johns Hopkins University
Departmental Honors GPA 3.9/4.0

PROFESSIONAL EXPERIENCE

2012-present **Chair, Chemical and Biomolecular Engineering and Catherine and Henry Boh Professor in Engineering**
Tulane University, School of Science and Engineering

2012-present **Adjunct Professor**
University of Delaware, Department of Chemical and Biomolecular Engineering

2008-2011 **Associate Chair for Biochemical Engineering**
University of Delaware, Department of Chemical Engineering

2008-2011 **Full Professor**
University of Delaware, Department of Chemical Engineering

2003-2008 **Associate Professor**
University of Delaware, Department of Chemical Engineering

1997-2003 **Assistant Professor**
University of Delaware, Department of Chemical Engineering

1994-1997 **Postdoctoral Fellow**
Massachusetts Institute of Technology, Department of Biology
Advised by Professor Jonathan King.

ACADEMIC HONORS

2015 Perlman Awardee, American Chemical Society (ACS) BIOT division
2013 American Institute of Chemical Engineers (AIChE) Women's Initiatives Committee's (WIC) Mentorship Excellence Award
2011 Fellow, American Institute for Medical and Biological Engineering

2002	Outstanding Junior Faculty Member, College of Engineering, University of Delaware
2000-2005	NSF Presidential Early Career Award in Science and Engineering (PECASE/Career)
2000-2003	DuPont Young Professor
2000	National Academy of Engineering, Sixth Annual Frontiers in Engineering
1996-97	NIH Postdoctoral Fellowship
1992-94	Clare Booth Luce Graduate Fellowship
1989-92	Department of Defense Fellowship (NDSEG)
1988-89	NSF Creativity Award for Scientists and Engineers
1988	National Science Foundation Fellowship awarded (declined)
1988-89	Tau Beta Pi Fellowship
1984-88	Beneficial Hodson Scholarship, Johns Hopkins University

PATENTS

A) Kelly, R.M., A.K.S. Robinson, I.I. Blumentals, S.H. Brown, and C.B. Anfinsen. "Proteolytic Enzymes from Hyperthermophilic Bacteria and Processes for Their Production." Patent # 5,242,817. Filed 9/12/89. Accepted 9/7/93. Licensed to Takara Shuzo.

B) Robinson, A.S. and K.D. Wittrup. "Methods for Increasing Secretion of Overexpressed Proteins." Patent # 5,773,245. Filed 10/92. Accepted 6/30/98.

C) Robinson, A.S., D. Foguel, J.L. Silva, C.R. Robinson. "Use of Hydrostatic Pressure to Inhibit and Reverse Protein Aggregation and Facilitate Protein Refolding." Patent applied for, 60/161,035. Filed 10/99. Issued 11/10/09.

BOOK PUBLICATION

1) Russell, T.W.F., Robinson, A.S., and Wagner, N.J., (2008) Mass and Heat Transfer: Analysis of Mass Contactors and Heat Exchangers, Cambridge University Press, Cambridge, UK (www.cambridge.org/9780521886703).

2) Robinson, A.S., ed (2011) Production of Membrane Proteins – Strategies for Expression and Isolation, Wiley VCH (http://onlinelibrary.wiley.com/book/10.1002/9783527634521)

JOURNAL PUBLICATIONS (SINCE 2005)

32) Niebauer, R. T., and A.S. Robinson* (2006) "Exceptional total and functional yields of the human adenosine (A2a) receptor expressed in the yeast Saccharomyces cerevisiae", *Prot. Exp. Purif.*, 46, p. 204-211.

33) Gage, M.J, Lefebvre, B.G., and A.S. Robinson* (2006) "Determinants of Protein Folding and Aggregation in P22 Tailspike," in Misbehaving Proteins, ACS Publications, eds. Regina Murphy and Amos Tsai.

34) Kim, J. and Robinson, A.S.* (2006) Dissociation of intermolecular disulfide bonds in P22 tailspike protein intermediates in the presence of SDS, *Protein Science*, 15 (7), p. 1791-3.

35) Wedekind, A.L.†, O'Malley, M., Niebauer, R.T., and Robinson, A.S.* (2006) Optimization of the Human Adenosine A_2a Receptor Yields in *Saccharomyces cerevisiae, Biotechnology Progress,* 22(5):1249-55. PMID:17022661; DOI: 10.1021/bp050431r

36) Powers, S.L., Robinson, C.R., and Robinson, A.S.* (2007) Denaturation of an Extremely Stable Hyperthermophilic Protein Occurs via a Dimeric Intermediate, *Extremophiles*, 11(1):179-89.

37) Forsten-Williams*, K.F., Cassino, T.R, Delo, L.J., Bellis, A.D., Robinson, A.S., and Ryan, T.E., (2007) Enhanced Insulin-like Growth Factor-I (IGF-I) Cell Association at Reduced pH is Dependent on IGF Binding Protein-3 (IGFBP-3) Interaction, *Journal of Cellular Physiology*, 210(2):298-308.

38) Famá, M.C., Raden, D., Zacchi, N., Lemos, D.R., Robinson, A.S., and Silberstein, S. * (2007) "The *Saccharomyces cerevisiae* YFR041C/ERJ5 gene encoding a type I membrane protein with a J domain is required to preserve the folding capacity of the endoplasmic reticulum" *Biochim Biophys Acta,* 1773(2):232-42.

39) Bane, S.E., Velasquez, J.E. †, and A.S. Robinson* (2007) "Expression and purification of milligram levels of inactive G-protein coupled receptors in *E. coli*", *Protein Expression and Purification*, 52(2):348:355. PMID: 17166740; DOI: 10.1016/j.pep.2006.10.017

40) Powers, S.L. and A.S. Robinson* (2007) "PDI Improves Secretion of Redox-Inactive β-glucosidase", *Biotech Prog*., Mar-Apr;23(2):364-9. E-pub Feb 22, DOI: 10.1021/bp060287p

41) McCusker, E., Bane, S.E., O'Malley, M., and A.S. Robinson * (2007), "Heterologous GPCR expression: A bottleneck to obtaining crystal structures", *Biotech Progress*, May-Jun;23(3):540-7. PMID:17397185

42) O'Malley, M., Lazarova, T., Britton, Z.T., and Robinson, A.S. * (2007) "High-level expression in *Saccharomyces cerevisiae* enables isolation and spectroscopic characterization of functional human adenosine A_2a receptor", *J. Struct Biol*., 159(2): 166-178. PMID: 17591446

43) McCusker, E., and Robinson, A.S.*, (2008) Refolding of G protein α subunits from inclusion bodies expressed in *Escherichia coli*, *Protein Exp. Purif.*, Apr;58(2): 342-55. PMID: 18249008

44) Hildebrandt, S., D. Raden, L. Petzold, A.S. Robinson, and F.J. Doyle III* (2008) "A top-down approach to mechanistic biological modeling: application to the single-chain antibody folding pathway", *Biophysical Journal*, 95(8):3535-58. Epub 2008 Jul 18. PMID: 18641066

45) Webber T, Gurung S, Saul J, Baker T, Spatara M, Freyer M, Robinson AS, Gage MJ* (2009) "The C-terminus of the P22 tailspike protein acts as an independent oligomerization domain for monomeric proteins.", *Biochem J*. May 1;419(3):595-602. PMID: 19196242

46) Spatara ML, Roberts CJ, Robinson AS* (2009) "Kinetic folding studies of the P22 tailspike beta-helix domain reveal multiple unfolded states." *Biophys Chem.* 141(2-3):214-21. PMID: 19258192

47) Xu, P. and Robinson, A.S.* (2009) "Decreased secretion and unfolded protein response up-regulation are correlated with intracellular retention for single-chain antibody variants produced in yeast" *Biotech & Bioeng*, 104(1):20-9. PMID: 19415776

48) O'Malley MA, Mancini JD†, Young CL, McCusker EC, Raden D, Robinson AS*.(2009) "Progress toward heterologous expression of active G-protein-coupled receptors in Saccharomyces cerevisiae: Linking cellular stress response with translocation and trafficking." *Protein Sci.* 18(11):2356-2370. PMID: 19760666; DOI: 10.1002/pro.246

49) Spatara, ML and Robinson, AS* (2010) "Transgenic mouse and cell culture models demonstrate a lack of mechanistic connection between endoplasmic reticulum stress and tau dysfunction" Journal of Neuroscience Research, 88(9):1951-61. PMID: 20143409

50) O'Malley, MA, AN Naranjo, T Lazarova, AS Robinson* (2010) "Analysis of Adenosine A_2a Receptor Stability: Effects of Ligands and Disulfide Bonds", *Biochemistry*, Nov 2;49(43):9181-9. PMID: 20853839

51) Yuraszeck, TM, Neveu, P, Rodriguez-Fernandez, M, Robinson, AS, Kosik, KS, and FJ Doyle III* (2010) Vulnerabilities in the Tau Network and The Role of Ultrasensitive Points in Tau Pathophysiology, *PLoS Computational Biology*, 6(11): e1000997. doi:10.1371/journal.pcbi.1000997 (with cover art)

52) O'Malley, MA, Helgeson, ME, Wagner, NJ and AS Robinson* (2011) Morphology and Composition of Cholesterol-rich Micellar Nanostructures Determine Transmembrane Protein (GPCR) Activity, *Biophysical Journal*, 100(2): L11-13. PMID: 3021673.

53) Sahin, E, JL Jordan, ML Spatara, AN Naranjo, WF Weiss IV, AS Robinson, EJ Fernandez*, CJ Roberts* (2011) "Computational Design and Biophysical Characterization of Aggregation-Resistant Point Mutations for γD Crystallin Illustrate a Balance of Conformational Stability and Intrinsic Aggregation Propensity", *Biochemistry*, Feb 8;50(5):628-39. PMID: 21184609

54) Young CL, Yuraszeck T, Robinson AS* (2011) "Decreased secretion and unfolded protein response upregulation," *Methods Enzymol*. 491:235-60. PMID: 21329804
55) Robinson, A.* (2011) "New Tools for Breaking Barriers to GPCR Expression in *E. coli*" *Journal of Molecular Biology*. 408 (4): 597-598 PMID: 21420418
56) Britton, Z., Young, C., Can, Ö., McNeely, P., Naranjo, A. and Robinson, A. S. (2012) Membrane Protein Expression in *Saccharomyces cerevisiae*, in Production of Membrane Proteins: Strategies for Expression and Isolation (ed A. S. Robinson), Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, Germany. doi: 10.1002/9783527634521.ch2
57) O'Malley, Michelle A., Matthew E. Helgeson, Norman J. Wagner, Anne S. Robinson[*] (2011) "Toward Rational Design of Protein Detergent Complexes: Determinants of Mixed Micelles that are Critical for the *in vitro* Stabilization of a G-protein Coupled Receptor", *Biophysical Journal*, 101 (8): 1938-1948. DOI: 10.1016/j.bpj.2011.09.018 PMID: 22004748
58) Griesemer, M, Young, CL, Doyle III, FJ, Robinson, AS and L Petzold[*] (2012) Spatial Localization of Chaperone Distribution in the Endoplasmic Reticulum of Yeast, *IET Systems Biology*, 6(2):54-63. http://dx.doi.org/10.1049/iet-syb.2011.0006
59) Young, CL, ZT Britton, AS Robinson,* (2012) "Recombinant Protein Expression and Purification: A Comprehensive Review of Affinity Tags and Microbial Applications" *Biotechnology Journal*, May;7(5):620-34. doi: 10.1002/biot.201100155. Epub 2012 Jan 10. PMID: 22442034
60) Young, CL, DL Raden, J Caplan, K Czymmek, AS Robinson,* (2012) "Cassette Series Designed for Live-Cell Imaging of Proteins and High Resolution Techniques in Yeast", *Yeast*, Mar;29(3-4):119-36. doi: 10.1002/yea.2895. Epub 2012 Apr 4. PMID: 22473760
61) Britton, ZT, EI Hanle[†], and AS Robinson[*] (2012) An Expression and Purification System for the Biosynthesis of Adenosine Receptor Peptides for Biophysical and Structural Characterization, *Protein Exp. Purif.*, 84:224-235. PMID: 22722102; DOI: 10.1016/j.pep.2012.06.005
62) McNeely, P.M., Naranjo, A.N., and A.S. Robinson* (2012) Structure-function studies with G-protein coupled receptors as a paradigm for improving drug discovery and therapeutic development, *Biotechnology Journal*, 7(12): 1451-1461. DOI: 0.1002/biot.201200076 PMID: 23213015
63) Young, CL, DL Raden, AS Robinson,* (2013) Analysis of ER Resident Proteins in *S. cerevisiae*: Implementation of H/KDEL Retrieval Sequences, *Traffic*, 14(4):365-81. DOI: 10.1111/tra.12041. PMID: 23324027
64) Morozova, OA, ZM March[†], AS Robinson, and DW Colby[*] (2013) Conformational features of tau fibrils from Alzheimer's disease brain are faithfully propagated by unmodified recombinant protein, *Biochemistry*, 52(40):6960-7. http://dx.doi.org/10.1021/bi400866w PMID: 24033133
65) Maurer, Ronald W., Alan K Hunter, Xiangyang Wang, William K Wang, Anne S Robinson, and Christopher J. Roberts[*] (2013) Folding and aggregation of a multi-domain engineered immunotoxin, *Biochemical Engineering Journal*, 81: 8-14. http://dx.doi.org/10.1016/j.bej.2013.09.015.
66) Blanco, M, Sahin, E, Robinson, A, Roberts, C[*] (2013) Coarse-Grained Model for Colloidal Protein Interactions, B_{22}, and Protein Cluster Formation, *The Journal of Physical Chemistry, Part B,* Dec 19;117(50):16013-28. doi: 10.1021/jp409300j PMID: 24289039
67) Maurer, RW, AK Hunter, AS Robinson[*], and CJ Roberts[*] (2014) Aggregates of alpha-chymotrypsinogen anneal to access more stable states, *Biotechnology & Bioengineering*, 111 (4): 782-791. doi: 10.1002/bit.25129 PMID: 24122552
68) St. Amand, MM, Ogunnaike, BA, and Robinson, AS[*] (2014) Development of At-Line Assay to Monitor Charge Variants of mAbs During Production, *Biotechnology Progress*, 30: 249–255. DOI: 10.1002/btpr.1848 PMID: 24382831

69) St. Amand, MM, K Tran[†], D Radhakrishnan, AS Robinson, BA Ogunnaike[*] (2014) Controllability Analysis of Protein Glycosylation in CHO cells, *PLoS One*, 9(2): e87973. DOI: 10.1371/journal.pone.0087973
70) Wu, H, R Kroe-Barrett, S Singh, AS Robinson, CJ Roberts[*] (2014) Competing aggregation pathways for monoclonal antibodies, *FEBS Letters* 588(6): 936-941. http://dx.doi.org/10.1016/j.febslet.2014.01.051
71) JA Costanzo, CJ O'Brien, K Tiller[†], E Tamargo[†], AS Robinson, CJ Roberts, and EJ Fernandez,* (2013) Computational Design to Control Protein Aggregation Rates Through Conformational Stability, *Protein Eng, Des, & Sel*, 27 (5): 157-167. 10.1093/protein/gzu008
72) St. Amand, MM, D Radhakrishnan, AS Robinson, BA Ogunnaike[*] (2014) Identification of Manipulated Variables for a Glycosulation Control Strategy, *Biotech Bioeng*, in press. Available online: 22 MAY 2014 DOI: 10.1002/bit.25251
73) Griesemer, M., Young, C., Robinson, A.S., Petzold, L.[*] (2014) BiP Clustering Facilitates Protein Folding in the Endoplasmic Reticulum, *PLOS Computational Biology*, 10(7):1-16, 10.1371/journal.pcbi.1003675
74) Young, CL and AS Robinson[*] (2014) Protein Folding and Secretion: Mechanistic Insights Advancing Recombinant Protein Production in *S. cerevisiae, Current Opinion in Biotechnology*, 30: 168-177. Available online 15 July 2014 DOI: 10.1016/j.copbio.2014.06.018
75) Naranjo, AN, A Chevalier[†], GD Cousins[†], E Ayettey[†], EC McCusker, C Wenk, AS Robinson (2015) Conserved disulfide bond is not essential for the adenosine A2A receptor: extracellular cysteines influence receptor distribution within the cell and ligand-binding recognition, *BBA Biomembranes*, 1848: 603-614 Available on-line Dec 5 2014 DOI: 10.1016/j.bbamem.2014.11.010
76) Blocker, KM, ZT Britton, AN Naranjo, PM McNeely, CL Young, AS Robinson[*], (2015) Recombinant G protein-coupled receptor expression in *Saccharomyces cerevisiae* for protein characterization, in "Membrane Proteins – Production and Function Characterization", *Methods Enzymol*., 556:165-83. doi: 10.1016/bs.mie.2014.12.025
77) Wu, H, K Truncali, J Ritchie, R Kroe-Barrett, S Singh, AS Robinson, and CJ Roberts[*] (2015) Weak protein interactions and pH- and temperature-dependent aggregation of human Fc1, *mAbs*, in press

PEER-REVIEWED CONFERENCE PROCEEDINGS

1) Hildebrandt, S., D. Raden, E. Bell[†], A.S. Robinson, and F.J. Doyle III* (2005) "Modeling the Unfolded Protein Response in Saccharomyces Cerevisiae", Proc. Int. Conf. Foundations of Systems Biology, Santa Barbara, California. [not indexed]
2) Griesemer, M., Young, C., Raden, D., Petzold, L., Robinson, A.S., Doyle, F.J. [*] (2007) "Computational Modeling of Chaperone Interactions in the Endoplasmic Reticulum of *Saccharomyces cerevisiae.*" Proc. Int. Conf. Foundations of Systems Biology, Stuttgart, Germany.
3) Yuraszeck, T., Raden, D, Robinson, A.S., and Doyle, F.J.[*] (2007) "Microarray Analysis of the Unfolded Protein Response in *S. cerevisiae* Reveals Evidence of Down-regulation." Proc. Int. Conf. Foundations of Systems Biology, Stuttgart, Germany.
4) Yuraszeck, Theresa M., Pierre Neveu, Maria Rodriguez-Fernandez, Anne Robinson, Kenneth S. Kosik, Francis J. Doyle III (2009) Development of a mathematical model to investigate the pathophysiology of tau protein." Proc. Int. Conf. Foundations of Systems Biology, Denver, CO.

GRADUATE RESEARCH THESES

PhD Students

1) Brian Lefebvre, May 2002; High Pressure Dissociates Tailspike Aggregates and Promotes Native Structure Formation; Assistant Professor, Rowan University, NJ (2004-2008); Current Position, Senior Research Engineer, DuPont & Co.
2) James Butz, June 2002; Characterizing and Optimizing GPCR Expression in Yeast; 2005-2006, Senior Scientist, Schering-Plough; 2006-2011, Associate Principal Scientist, Schering-Plough, NJ. Current position, Principal Scientist, Merck & Co.
3) Brenda Danek, March 2003; Characterization of the Role of Disulfides in Folding of Tailspike Protein; J.D., 2008, NYU; current position: Associate, Leydig, Voit & Mayer, LLP
4) Jessica Sinacola, August, 2003; Characterization and Reversal of the Aggregation of Single-Chain Antibodies; current position, Process Engineer, Sterile Process Technology & Engineering, Merck & Co, West Point, PA.
5) Jason Smith, July 2003; Folding and Expression of Extremophilic Enzymes; 2003-2006 Postdoctoral Fellow, Carnegie Mellon University; 2006-2007, Product Development Engineer, Cohera Medical, Pittsburgh, PA; current position, Manager of Research and Development at Carmell Therapeutics.
6) Ronald Niebauer, July 2005; Using GFP as a Sensor for Optimizing Expression of GPCRs; current position, Biotechnology Patent Examiner, US Patent Office, Washington, DC.
7) Junghwa Kim, June 2006; Roles of Folding Intermediate Conformation and Transient Disulfide Bonding on the Folding of P22 Tailspike Protein; current position, Scientist, MedImmune.
8) Sara Lawrence Powers, July 2006; Characterization and Expression of an Extremely Stable Hyperthermophilic Protein; 2006-2008, Postdoctoral Fellow, Wistar Institute; current position, Biomatrica.
9) Ping Xu, July 2006; Sensing and Analyzing the Unfolded Protein Response during Heterologous Protein Production; current position, Scientist, Glaxco Smith Kline.
10) Steven Bane, May 2007; Expression and Characterization of the Human Neurokinin 1 receptor from *E. coli*; Process Engineer, Sterile Process Technology & Engineering, Merck & Co, West Point, PA, 2007-2011; current position, Scientist, Amgen
11) Emily McCusker, December 2007; Overcoming Expression Obstacles in Producing Functional Components of the G-Protein Coupled Receptor Pathway; current position, Teva Pharmaceuticals.
12) Michelle Spatara, May 2009; Protein folding and aggregation *in vitro* and *in vivo*; current position, Investigator, GSK.
13) Michelle O'Malley, August 2009; Expression, Purification, and Biophysical Characterization of G-Protein Coupled Receptors Expressed from Saccharomyces cerevisiae; current position, Assistant Professor, UC Santa Barbara
14) Carissa Young, December 2012; Interrogation of Quality Control Mechanisms and Protein Trafficking in *Saccharomyces cerevisiae*; current position, post-doctoral fellow, MIT
15) Zachary Britton, December 2012; Novel Approaches to the Expression and Purification of G Protein-coupled Receptors; current position, Scientist, MedImmune
16) Melissa St. Amand, September 2013; Toward Online Quality Control during Biopharmaceutical Production; current position, post-doctoral fellow, Biotechnology Core Lab., ODIR, NIDDK, NIH
17) Andrea Naranjo, October 2014; Stability and Activity of a GPCR in vivo and in Membrane Mimetic Environments; post doc, NIH
18) Patrick McNeely, July 2015; Receptor-receptor, Ligand, and Membrane Interactions of the Adenosine A_{2A} Receptor

MChE Students

1) Sujata Bhatia, BChE/MChE, May 1999, Novel Role for Cysteines in *in vivo* folding of P22 Tailspike Protein; M.D./Ph.D, UPenn, 2003; Medical Research Scientist, DuPont Central Research & Development, Wilmington, DE, 2003-2011; current position, Assistant Director for Undergraduate Studies in Biomedical Engineering, Harvard University.

- Honors include: 1998 Barry M. Goldwater Award, 1999 AIChE Student Paper Award, 1999 NSF and NDSEG graduate fellowships

2) Nicole Sheatsley Richardson, March 2005; Optimizing Extremophile Expression in Yeast; Centocor, Malvern, PA, 2005-2008
3) Nathanial Macapagal, May 2011; Characterization of the Folding and Assembly of Single-Chain Antibodies; current position, Associate Scientist I, Purification Process Sciences, MedImmune.
4) Nikki Ross, January 2012; The Role of Oxidative Stress on Tau Protein Homeostasis in Neurodegenerative Diseases