

## Curriculum Vitae

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### Education:

1991-1994	University of Maryland	B.S. in Chemistry and Biochemistry
1994-2000	Stanford University	Ph.D. in Biochemistry

### Positions and experience:

1991-1994	Undergraduate research with Dr. R. N. Armstrong, University of Maryland; Substrate specificity in Glutathione-S-Transferase.
1994-2000	Doctoral research with Dr. Daniel Herschlag, Stanford University; (1) Energetics of hydrogen bonds in model systems and implications for enzymatic catalysis; (2) The role of metal ions in catalysis of RNA enzymes.
2000-2005	Post-doctoral research with Dr. Peter Walter, U.C. San Francisco Mechanism of Signal Recognition Particle-dependent protein transport
2005-2011	Assistant Professor, California Institute of Technology
2011-present	Professor, California Institute of Technology

### Honors/Awards

1992	CRC Freshman Chemistry Achievement Award
1998-1999	Lieberman Fellowship for Graduate Research
1999	Charles Yanofsky Graduate Research Award
2000-2003	Cancer Research Fund Fellowship, Damon Runyon-Walter Winchell Foundation
2000	Jane Coffin Childs Memorial Fund Fellowship (declined)
2003-2008	Career Award in Biomedical Sciences, Burroughs Wellcome Fund
2005-2008	Camille and Henry Dreyfus New Faculty Award
2007-2010	Beckman Young Investigator Award, Arnold and Mable Beckman Foundation
2007-2012	David and Lucille Packard Fellowship for science and engineering
2008	Woman in Cell Biology junior award, American Society of Cell Biology
2009	Camille and Henry Dreyfus Teacher-Scholar award
2011	Irving Sigal Young Investigator Award, the Protein Society
2011-current	Board of Reviewing editors, Molecular Biology of the Cell
2012	Nobel Laureate Signature Award for Graduate Education, American Chemical Society

2013	Young Investigator Award, American Society of Biochemistry and Molecular Biology
2013-current	Editorial Advisory board, Biochemistry
2013-2015	Associate Editor, Journal of Biological Chemistry

**Publications** (\*denotes the corresponding author)

1. Rao, M., Chio, U. S., Okreglak, V., Walter, P., and Shan, S.O.\* (2016) *eLife*, under revision. “Multiple selection filters ensure accurate tail-anchor membrane protein targeting”.
2. Liang, F.-C., Kroon, G., McAvoy, C., Chi, C., Wright, P.\* , and Shan, S.O.\* (2016) *Proc. Natl. Acad. Sci. U. S. A.*, pii: 201524777. “Conformational dynamics of a membrane protein chaperone enables spatially-regulated substrate capture and release”.
3. Chen, Y., Shen, K., Shan, S.O.\* , and Kou, S.C.\* (2016) *Journal of the American Statistical Association*, accepted. “Analyzing single-molecule protein transportation experiments via hierarchical hidden Markov Models”.
4. Gristick, H.B., Rome, M.E., Chartron, J., Rao, M., Hess, S., Shan, S.O.\* and Clemons, W.M.Jr.\* (2015) *J. Biol. Chem.* doi:10.1074/jbc.M115.677328. “Mechanism of assembly of a substrate-transfer complex during tail-anchored protein targeting”.
5. Ariosa, A.R., Lee, J.H., Wang, S., Saraogi, I., and Shan, S.\* (2015) *Proc. Natl. Acad. Sci. U. S. A.*, 112: E3169-3178.. “Regulation by a chaperone improves substrate selectivity during cotranslational protein targeting”. PMID: 26056263
6. von Loeffelholz, O., Jiang, Q., Ariosa, A., Karuppasamy, M., Huard, K., Berger, I., Shan, S., Schaffitzel, C.\* (2015) *Proc. Natl. Acad. Sci. U. S. A.* 112: 3943-3948. “Ribosome-SRP-FtsY cotranslational targeting complex in the closed state”. PMCID: PMC4386334
7. Rome, M.E., Chio, U.S., Rao, M., Gristick, H.B., and Shan, S.\* (2014) *Proc. Natl. Acad. Sci. U. S. A.*, 111: E4929-4935. “Differential gradients of interaction affinities drive efficient targeting and recycling in the GET pathway”. PMCID: PMC4246279
8. Saraogi, I.\* , Akopian, D., and Shan, S.\* (2014) *J. Cell Biol.*, 205: 693-706. “Regulation of cargo recognition, commitment, and unloading drives cotranslational protein targeting”. PMCID: PMC4050729
9. Zhang, X. and Shan, S.\* (2014) *Annu. Rev. Biophys.*, 43: 381-408. “Fidelity of cotranslational protein targeting by the Signal Recognition Particle”. PMCID: PMC4444370
10. Guo, H., Xiong, Y., Witkowski, P., Cui, J., Wang, L.J., Sun, J., Lara-Lemus, R., Haataja, L., Hutchison, K., Shan, S.\* , Arvan, P.\* , and Liu, M.\* (2014) *J. Biol. Chem.*, 289: 16290-16302. “Inefficient translocation of preproinsulin contributes to pancreatic Beta Cell Failure and late onset diabetes.” PMCID: PMC4047398
11. Gristick, H.B., Rao, M., Chartron, J.W., Rome, M.E., Shan, S., and Clemons, W.M.Jr.\* (2014) *Nature Struct. Molec. Biol.*, 21: 437-442. “Crystal structure of ATP-bound Get3-Get4-Get5 complex reveals regulation of Get3 by Get4”. PMCID: PMC4386898
12. Saraogi, I., and Shan, S.\* (2014) *Biochim Biophys Acta.*, 1843: 1433-1441. “Co-translational protein targeting to the bacterial membrane.” PMCID: PMC3999308

13. Loson, O.C., Liu, R., Rome, M.E., Meng, S., Kaiser, J.T., Shan, S.O. and Chan, D.C.\* (2014) *Structure*, 22: 367-377. “The mitochondrial fission receptor Mid51 requires ADP as a cofactor”. PMID: PMC4066849
  14. Voigts-Hoffmann, F., Schmitz, N., Shen, K., Shan, S.O.\*, Ataide, S.F.\*, Ban, N.\* (2013) *Mol. Cell*, 52: 643-54. “The structural basis of FtsY recruitment and GTPase activation by SRP RNA”. PMID: PMC3910249
  15. Shen, K., Wang, Y., Hwang Fu, Y.H., Zhang, Q., Feigon, J., and Shan, S.\* (2013) *J. Biol. Chem.*, 288: 36385-97. “Molecular Mechanism of GTPase activation at the signal recognition particle (SRP) RNA distal end”. PMID: PMC3868752
  16. Rome, M., Rao, M., Clemons, W.M., and Shan, S.\* (2013) *Proc. Natl. Acad. Sci. U. S. A.*, 110: 7666-7671. “Precise timing of ATPase activation drives targeting of tail-anchored proteins”. PMID: PMC3651441
  17. von Loeffelholz, O., Knoop, K., Ariosa, A., Zhang, X., Karuppusamy, M., Huard, K., Schoehn, G., Berger, I., Shan, S.\*, Schaffitzel, C.\* (2013) *Nature Struct. Mol. Biol.*, 20: 604-610. “Structural basis of signal sequence surveillance and selection by the SRP-SR complex”. PMID: PMC3874396
  18. Nguyen, T.X., Jaru-Ampornpan, P., Lam, V.Q., Cao, P., Piszkiwicz, S., Hess, S., Shan, S.\* (2013) *J. Biol. Chem.*, 288: 13420-13430. “Mechanism of an ATP-independent protein disaggregase. I. Structure of a membrane protein aggregate reveals a mechanism of recognition by its chaperone”. PMID: PMC3650380
  19. Jaru-Ampornpan, P., Liang, F.C., Nisthal, A., Nguyen, T.X., Wang, P., Shen, K., Mayo, S.L., Shan, S.\* (2013) *J. Biol. Chem.*, 288: 13431-13445. “Mechanism of an ATP-independent protein disaggregase. II. Distinct molecular interactions drive multiple steps during aggregate disassembly”. PMID: PMC3650381.
  20. Akopian, D., Shen, K., Zhang, X. and Shan, S.\* (2013) *Annu Rev. Biochem.* 82: 693-721. “Signal recognition particle: An essential protein targeting machine”. PMID: PMC3805129
  21. Perice, N.W., Lee, J.E., Liu, X., Sweredoski, M.J., Graham, R.L., Larimore, E.A., Rome, M., Zheng, N., Cluman, B.E., Hess, S., Shan, S.O. ‡, Deshaies, R.J. ‡\* (2013) *Cell* 153: 206-215. “Cand1 promotes assembly of new SCF complexes through dynamic exchange of F box proteins”. PMID: PMC3656483
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22. Akopian, D., Dalai, K., Shen, K., Duong, F., Shan, S.\* (2013) *J. Cell Biol.* 200: 397-405. “SecYEG activates GTPases to drive the completion of cotranslational protein targeting”. PMID: PMC3575545. **Highlight in:** *J. Cell Biol.* 200, p362 (2013).
  23. Ariosa, A.R., Duncan, S.S., Saraogi, I., Lu, X., Brown, A., Phillips, G.J., and Shan, S.\* (2013) *Mol. Biol. Cell*, 24: 63-73. “Fingerloop activates cargo delivery and unloading during cotranslational protein targeting”. PMID: PMC3541965
  24. Shen, K., Arslan, S., Akopian, D., Ha, T., and Shan, S.\* (2012) *Nature* 492: 271-275. “Activated GTPase movement on an RNA scaffold drives cotranslational protein targeting.” PMID: PMC3531814. **News & Views on:** *Nature* 492: 271-275 (2012).

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  26. Zhang, D., and Shan, S.\* (2012) *J. Biol. Chem.*, 287: 7652-7660. "Translational elongation regulates substrate selection by the Signal Recognition Particle." PMID: PMC3293578
  27. Zhang, D., Sweredoski, M.J., Graham, R.L., Hess, S., Shan, S.\* (2012) *Mol Cell Proteomics*, 11: M111.011585. "Novel proteomic tools reveal essential roles of SRP and importance of proper membrane protein biogenesis." PMID: PMC3277757
  28. Saraogi, I., Akopian, D., and Shan, S.\* (2011) *Protein Sci.*, 20:1790-5. "A Tale of two GTPases in co-translational protein targeting." PMID: PMC3267943
  29. Saraogi, I., Zhang, D., Chandrasekaran, S., and Shan, S.\* (2011) *JACS*, 133:14936-9. "Site-specific fluorescent labeling of nascent proteins on the translating ribosome". PMID: PMC3189723
  30. Nguyen, T., Chandrasekar, S., Neher, S., Walter, P., and Shan, S.\* (2011) *Biochemistry*, 50:7208-7217. "Concerted complex assembly and GTPase activation in the chloroplast signal recognition particle". PMID: 21780778
  31. Zhang, X., Lam, V.Q., Mou, Y., Kimura, T., Chung, J., Chandrasekar, S., Winkler, J., Mayo, S.L., and Shan, S.\* (2011) *Proc. Natl. Acad. Sci. U.S.A.*, 108: 6450-6455. "Direct visualization reveals dynamics of a transient intermediate during protein assembly". PMID: PMC3081034
  32. Shen, K., Zhang, X., and Shan, S.\* (2011) *RNA* 17: 892-902. "Synergistic action between the SRP RNA and translating ribosome allows efficient delivery of correct cargos during co-translational protein targeting". PMID: PMC3078738
  33. Saraogi, I., and Shan, S.\* (2011) *Traffic* 12: 535-542. "Molecular mechanism of co-translational protein targeting by the Signal Recognition Particle". PMID: PMC3077218
  34. Attaide, S.F., Schmitz, N. ‡, Shen, K. ‡, Ke, A., Shan, S., Doudna, J. A.\*, and Ban, N.\* (2011) *Science* 381, 881-886. "The crystal structure of the Signal Recognition Particle in complex with its receptor". PMID: 21330537
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35. Estrozi, L.F., Boehringer, D., Shan, S., Ban, N.\*, and Schaffitzel, C.\* (2011) *Nature Struct. Mol. Biol.* 18: 88-90. "Cryo-EM structure of the *E. coli* translating ribosome in complex with SRP and its receptor". PMID: PMC3764645
  36. Lam, V.Q., Akopian, D., Rome, M., Shen, Y., Henningsen, D., and Shan, S.\* (2010) *J. Cell Biol.* 190: 623-635. "Lipid activation of the signal recognition particle receptor provides spatial coordination of protein targeting". PMID: PMC2928010
  37. Jaru-Ampornpan, P., Shen, K., Lam, V.Q., Ali, M., Doniach, S., Jia, T.Z., and Shan, S.\* (2010) *Nature Struct. Mole. Biol.* 17, 696-702. "ATP-independent reversal of a membrane protein aggregate by a chloroplast SRP subunit". PMID: 20424608. **News & Views on:** *Struct. Mole. Biol.* 17: 676-677 (2010). PMID: PMC2917185
  38. Zhang, X., Rashid, R., Wang, K., and Shan, S.\* (2010) *Science* 328, p757-760. "Sequential checkpoints govern substrate selection during cotranslational protein targeting". PMID: PMC3760334

39. Shen, K., and Shan, S.\* (2010) *Proc. Natl. Acad. Sci. U. S. A.* 107, 7698-7703. “Transient tether between the SRP RNA and SRP receptor ensures efficient cargo delivery during cotranslational protein targeting”. PMID: PMC2867919
40. Pierce, N., Kleiger, G., Shan, S. ‡, and Deshaies R.J. ‡\* (2009) *Nature* 462, 615-619. “Detection of sequential polyubiquitylation on a millisecond timescale”. PMID: PMC2791906  
‡These authors contributed equally to this work. **News & Views in:** *Nature* 462: 585-586 (2009).
41. Jaru-Ampornpan, P., Nguyen, T. X., and Shan, S.\* (2009) *Mol. Biol. Cell* 20, 3965-3973. “A distinct mechanism to achieve efficient signal recognition particle (SRP)-SRP receptor interaction by the chloroplast SRP pathway”. PMID: PMC2735494
42. Shan, S.\*, Schmid, S.L., and Zhang, X. (2009) *Biochemistry* 48, 6696-6704. “Signal recognition particle (SRP) and SRP receptor: a new paradigm for multi-state regulatory GTPases”. PMID: PMC2883566
43. Zhang, X., Schaffitzel, C., Ban, N., and Shan, S.\* (2009) *Proc. Natl. Acad. Sci. U. S. A.* 106, 1754-1759. “Multiple conformational switches in a GTPase complex control co-translational protein targeting”. PMID: PMC2644110
44. Zhang, X., Kung, S., and Shan, S.\* (2008) *J. Mol. Biol.* 381, 581-593. “Demonstration of a multi-step mechanism for assembly of the SRP-SRP receptor complex: Implications for the catalytic role of SRP RNA”. PMID: PMC2630804
45. Chandrasekar, S., Chartron, J., Jaru-Ampornpan, P., and Shan, S.\* (2008) *J. Mol. Biol.* 375, 425-436. “Structure of the chloroplast signal recognition particle (SRP) receptor: domain arrangement modulates the SRP-receptor interaction”. PMID: 18035371
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51. Shan, S.\*, Stroud, R.M., and Walter, P. (2004) *PLOS Biology* 2, e320. “Mechanism of association and reciprocal activation between two GTPases”. PMID: PMC517823
52. Egea, P.F., Shan, S., Napetschnig, J., Savage, D.F., Walter, P., and Stroud, R.M.\* (2004) *Nature* 427, 215-221. “Substrate twinning activates the signal recognition particle and its receptor”. PMID: 14724630

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54. Shan, S., and Herschlag, D.\* (2002) *RNA* **8**, 861-872. “Dissection of a metal-ion-mediated conformational change in *Tetrahymena* ribozyme catalysis”. PMID: PMC1370303
55. Peluso, P., Shan, S., Nock, S. Herschlag, D., and Walter, P.\* (2001) *Biochemistry* **40**, 15224-15233. “Role of SRP RNA in the GTPase Cycles of Ffh and FtsY”. PMID: 11735405
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58. Yoshida, A.‡, Shan, S.‡, Herschlag, D., and Piccirilli, J.A.\* (1999) *Chem. Biol.* **7**, 85-96. "The role of the cleavage site 2'-Hydroxyl in the *Tetrahymena* group I ribozyme reaction". PMID: 10662698
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59. Shan, S., Yoshida, A., Sun, S., Piccirilli, J.A. and Herschlag, D.\* (1999) *Proc. Natl. Acad. Sci. U. S. A.* **96**, 12299-12304. "Three metal ions at the active site of the *Tetrahymena* group I ribozyme". PMID: 10535916
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65. Shan, S., Loh, S. and Herschlag, D.\* (1996) *Science* **272**, 97-101. "The energetics of hydrogen bonds in model systems. Implications for enzymatic catalysis". PMID: 8600542
66. Shan, S. and Armstrong, R.N.\* (1994) *J. Biol. Chem.* **269**, 32373-32379. "Rational reconstruction of the active site of a Class Mu Glutathione S-Transferase".
67. Zhang, P., Liu, S., Shan, S., Ji, X., Gilliland, G.L. and Armstrong, R.N.\* (1992) *Biochemistry* **31**, 10185-10193. "Modular mutagenesis of Exons 1, 2, and 8 of a Glutathione S-Transferase from the Mu Class: Mechanistic and structural consequences from Chimeras of Isoenzyme 3-3". PMID: 1420140