

Irene A. Chen

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Employment

11/12 - Present **Assistant Professor**
Department of Chemistry and Biochemistry
Program in Biomolecular Sciences and Engineering
University of California, Santa Barbara

Education

06/07 - 05/12 **Bauer Fellow**
FAS Center for Systems Biology
Harvard University
Research: Non-enzymatic polymerization of nucleic acids;
Prebiotic information storage; Fitness landscapes of RNA

07/99 - 06/07 **Ph.D. in Biophysics**
Harvard University
Thesis: Building a protocell: physical aspects and emergent behaviors.
Advisor: Jack Szostak

09/95 - 06/99 **M.D. in Health Sciences and Technology**
Harvard Medical School and the Massachusetts Institute of Technology
A.B. in Chemistry (*summa cum laude*)
Harvard University
Advisor: Gregory Verdine

Other Academic Training

06/12 - 12/12 **Guest Researcher**
Program for Evolutionary Dynamics
Harvard University
Research: Theoretical models of chemical evolution

Awards and Honors

2018 Camille Dreyfus Teacher-Scholar Award
2017 Regents Junior Faculty Fellowship
2016 NIH Director's New Innovator Award
2015 Hellman Family Faculty Fellowship
2014 Searle Scholar Award
2013-2023 Investigator of the Simons Collaboration on the Origins of Life
2011 David White Research Award from the International Society for the Study of the Origin of Life (given triennially)
2006 G.E. and *Science* Prize for Young Life Scientists
2005 Harold M. Weintraub Graduate Student Award
1998 Barry M. Goldwater Scholar
1995 Westinghouse Science Talent Search, 1st place

Publications (chronological order)

Undergraduate authors are underlined.

1. Kast P, Grisostomi C, **Chen IA**, Li S, Krengel U, Xue Y, Hilvert D. A strategically positioned cation is crucial for efficient catalysis by chorismate mutase. *J. Biol. Chem.* 2000, 275 (47): 36832-36838.
2. Straight AF, Cheung A, Limouze J, **Chen I**, Westwood NJ, Sellers JR, Mitchison TJ. Dissecting temporal and spatial control of cytokinesis with a myosin II inhibitor. *Science* 2003, 299 (5613): 1743-1747.
3. **Chen IA**, Szostak JW. Membrane growth can generate a transmembrane pH gradient in fatty acid vesicles, *Proc. Natl. Acad. Sci.* 2004, 101(21): 7965-7970.
4. **Chen IA**, Szostak JW. A kinetic study of the growth of fatty acid vesicles. *Biophys. J.* 2004, 87(2):988-98.
5. **Chen IA**, Roberts RW, Szostak JW. The emergence of competition between model protocells. *Science* 2004, 305(5689):1474-1476.
6. Fujikawa SM, **Chen IA**, Szostak JW. Vesicle shrink-wrap. *Langmuir* 2005, 21(12124 – 12129).
7. **Chen IA**, Salehi-Ashtiani K, Szostak JW. 2005. RNA catalysis in model protocell vesicles. *J. Am. Chem. Soc.* 2005, 127(38):13213-9.
8. **Chen IA**, Hanczyc MM, Szostak JW. Protocells: Genetic polymers inside membrane vesicles. In *RNA World*, 3rd ed. Gesteland RF, Cech TR, Atkins JF, eds. Cold Spring Harbor Laboratory Press. 2006.
9. **Chen, IA**. The emergence of cells during the origin of life. *Science* 2006, 314: 1558-1559.
10. Hanczyc MM, **Chen IA**, Szostak JW. Steps towards a synthetic protocell. In *Protocells: Bridging Nonliving and Living Matter*. Rasmussen S, Bedau MA, Chen L, Deamer D, Krakauer DC, Packard NH, Stadler PF, eds. MIT Press. 2008.

Independent Work

11. **Chen IA**. Cell division: breaking up is easy to do. *Current Biology* 2009, 19(8), R327-R328.
12. **Chen IA** and Walde P. From self-assembled vesicles to protocells. *Cold Spring Harb. Perspect. Biol.* 2010 Jul 1;2(7):a002170.
13. Manapat ML, **Chen IA**, Nowak MA. The basic reproductive ratio of life. *J. Theor. Biol.* 2010, 263(3): 317-327.
14. **Chen IA**, Schindlinger M. Quadruplet codons: One small step for a ribosome, one giant leap for proteins. *BioEssays*, 2010, 32: 650–654.
15. Rajamani S, Ichida JK, Antal T, Treco DA, Leu K, Nowak MA, Szostak JW, **Chen IA**. Effect of stalling after mismatches on the error catastrophe in non-enzymatic nucleic acid replication. *J. Am. Chem. Soc.* 2010, 132, 5880–5885.
This article is recommended by the Faculty of 1000.
16. **Chen IA**. An RNA Whirl. *Science* 2010. 330:758
17. Lin A, Jimenez J, Derr J, Vera P, Manapat ML, Esvelt KM, Villanueva L, Liu DR, **Chen IA**. Inhibition of bacterial conjugation by phage M13 and its protein g3p: quantitative analysis and model. *PLoS One* 2011, 6(5): e19991.
18. Leu K, Obermayer B, Rajamani S, Gerland U, **Chen IA**. The prebiotic evolutionary advantage of transferring information from RNA to DNA. *Nuc. Acids Res.* 2011, 39(18):8135-47.
19. Harris K, **Chen IA**. Mathematical models of prebiotic replication of informational molecules. In *Genesis - in the beginning: Precursors of Life, Chemical Models and Early Biological Evolution*. Seckbach, J, ed. Springer, 2012.
20. Derr J, Manapat ML, Rajamani S, Leu K, Xulvi-Brunet R, Joseph I, Nowak MA, **Chen IA**. Prebiotically plausible mechanisms increase compositional diversity of nucleic acid sequences. *Nuc. Acids Res.* 2012, 40(10):4711-22.
This paper was chosen by the editors as a Featured Article (top 5%).
21. **Chen IA*** and Nowak MA*. From prelife to life: how chemical kinetics become evolutionary dynamics. *Acc. Chem. Res.* 2012, 45(12):2088-2096.*co-corresponding authors
22. Vaidya N, Manapat ML, **Chen IA**, Xulvi-Brunet R, Hayden EJ, Lehman N. Spontaneous network formation among cooperative RNA replicators. *Nature*, 2012, 491:72-77.
This article was the subject of a Nature News and Views article and is recommended by the Faculty of 1000.
23. Leu K, Kervio E, Obermayer B, Turk-MacLeod R, Yuan C, Luevano J-M, Chen E, Gerland U, Richert C, **Chen IA**. Cascade of reduced speed and accuracy after errors in enzyme-free copying of nucleic acid sequences. *J. Am. Chem. Soc.* 2013, 135(1):354-366.
24. Turk-MacLeod R, Gerland U, **Chen IA**. Life: the physical underpinnings of replication. In *Astrochemistry and Astrobiology: Physical Chemistry in Action*, Smith I, Leach S, Cockell C., eds. Springer, 2012.

25. Leconte A, Dickinson B, Yang D, **Chen IA**, Allen B, Liu DR. A population-based experimental model for protein evolution: effects of mutation rate and selection stringency on evolutionary outcomes. *Biochemistry* 2013, 52:1490-1499.
26. Bianconi G, Zhao K, **Chen IA**, Nowak MA. Selection for replicases in protocells. *PLoS Comp. Biol.*, 2013, 9(5):e1003051.
27. Jimenez JI, Xulvi-Brunet R, Campbell G, Turk-MacLeod R, **Chen IA**. Comprehensive experimental fitness landscape and evolutionary network for small RNA. *Proc. Natl. Acad. Sci. USA*, 2013, 110(37):14984-9.
This article is recommended by the Faculty of 1000.
28. Ivica NA, Obermayer B, Campbell GW, Rajamani S, Gerland U, **Chen IA**. The paradox of dual roles in the RNA World: Resolving the conflict between stable folding and templating ability. *J. Mol. Evol.* 2013, 77(3):55-63.
29. Freese PD, Korolev KS, Jimenez JI, **Chen IA**. Genetic drift suppresses bacterial conjugation in spatially structured populations. *Biophys. J.*, 2014, 106(4):944-954.
30. Athavale SS, Spicer B, **Chen IA**. Experimental fitness landscapes to understand the molecular evolution of RNA-based life. *Curr. Opin. Chem. Biol.* 2014, 22:35-39.
An image from this article was chosen for the cover of this issue.
31. Saha R, Pohorille A, **Chen IA**. Molecular crowding and early evolution. *Orig. Life Evol. Biosph.* 2014, 44(4):319-24.
32. **Chen IA**. Replicating toward complexity. *Nat. Chem.* 2015, 7, 191-192.
33. Pressman A, Blanco C, **Chen IA**. The RNA World as a model system to study the origin of life. *Curr. Biol.* 2015, 25, R953-R963.
This article is recommended by the Faculty of 1000.
34. Saha R, **Chen IA**. Origin of life: Protocells red in tooth and claw. *Curr. Biol.* 2015, 201; 25(24):R1175-7.
35. Achenbach et al. NASA Astrobiology Strategy 2015.
http://astrobiology.nasa.gov/uploads/filer_public/01/28/01283266-e401-4dcb-8e05-3918b21edb79/nasa_astrobiology_strategy_2015_151008.pdf

This document is used to define NASA's Astrobiology priorities. It replaced the 2008 Astrobiology Roadmap. Irene Chen is one of 33 Lead Authors.

36. Xulvi-Brunet R, Campbell GW, Rajamani S, Jimenez JI, and **Chen IA**. Quantitative analysis of synthesized nucleic acid pools. In *Nonlinear Dynamics in Biological Systems*, Carballido-Landeira J and Escribano B, ed. Springer, 2016.
37. Xulvi-Brunet R*, Campbell GW*, Rajamani S, Jimenez JI, and **Chen IA**. Computational analysis of fitness landscapes and evolutionary networks from in vitro evolution experiments. *Methods* 2016, 106, 86-96.
38. **Chen IA*** and de Vries MS*. From underwear to non-equilibrium thermodynamics: physical chemistry informs the origin of life. *Phys. Chem. Chem. Phys.* 2016, 18, 20005-20006.
39. Pressman A, Moretti JE, Campbell GW, Muller UF*, **Chen IA***. Analysis of in vitro evolution reveals the underlying distribution of catalytic activity among random sequences. *Nucleic Acids Res.* 2017, 45: 8167-8179.
This paper was chosen by the editors to be a 'Breakthrough' article.
40. Blanco C, Bayas M, Yan F, **Chen IA**. Analysis of evolutionarily independent protein-RNA complexes yields a criterion to evaluate the relevance of prebiotic scenarios. *Curr. Biol.* 2018, 28: 526-537.
This paper was the subject of a "Dispatch" perspective article in Current Biology.
41. Saha R, Verbanic S, **Chen IA**. Lipid vesicles chaperone an encapsulated RNA aptamer. *Nat. Commun.*, 2018, 9:2313.
42. Blanco C and **Chen IA**. Connections between mathematical models of prebiotic evolution and homochirality. In *Prebiotic Chemistry and Chemical Evolution of Nucleic Acids*, Menor-Salvan C, ed. Springer Nature, 2018.
43. Blanco C, Janzen E, Pressman A, Saha R, **Chen IA**. Fitness landscapes from high coverage sequence profiling. *Ann. Rev. Biophys.* In press.
44. Peng H, **Chen IA**. Rapid colorimetric detection of bacterial species through capture of gold nanoparticles by chimeric phages. *ACS Nano*, in press.
45. Peng H, Verbanic S, **Chen IA**. Phage-targeted gold nanoparticles for detection and cell-killing in bacterial infections. Provisional patent filed, October 2, 2018 (USPTO).

Works in preparation

46. Pressman A, Liu Z, Janzen E, Blanco C, Muller UF, Joyce GF, **Chen IA**. Complete ribozyme fitness landscape shows a frustrated evolutionary network. In review.

47. Verbanic S, Kim YH, **Chen IA**. Improved methods for quantitative analysis of bacteria and phage from the skin microbiome. In review.
48. Austin et al. (Report authored collectively by ~30 workshop participants). Physics Next: Physics of living matter. *Rev. Mod. Phys.* In preparation.
49. Pressman A, **Chen IA**. Inferring the initial frequency distribution of fitness from time series data during experimental evolution. In preparation.

Funding

2013-14: Foundational Questions in Evolutionary Biology Fund
 2013-18: Simons Foundation
 2013-18: Institute for Collaborative Biotechnologies (UARC; US Army)
 2014-17: Searle Scholars Program
 2015-18: Institute for Collaborative Biotechnologies (UARC; US Army)
 2015-16: Hellman Family Faculty Fellowship
 2016-21: NIH Director's New Innovator Award (DP2)
 2016-19: NASA Exobiology Program
 2016-17: Simons Foundation
 2018-23: Simons Foundation (renewal)
 2018-23: Camille Dreyfus Teacher-Scholar Award Program
 2018-19: California NanoSystems Institute Challenge Grant

Teaching

| Quarter | Course number | Title |
|-------------------------|---------------|---|
| F13, F14, F15, F17, F18 | BMSE 201B | Nucleic Acids |
| W14, W16 | CHEM 290 | Seminar in Chemistry & Biochemistry |
| S14, S15, S17 | CHEM 142C | Biochemistry |
| W15 | CHEM 259 | Selected Topics in Biological Chemistry: Metagenomics |
| W17 | CHEM 1B | General Chemistry |
| S18 | CHEM 259 | Selected Topics in Biological Chemistry: Bacteriophages |

Extramural Activities

2009-14 Foundational Questions in Evolutionary Biology (Harvard), Board Member
 2013 National Research Council workshop on the future NASA Astrobiology Roadmap, Wallops Flight Center, VA
 2014-17 International Society for the Study of the Origin of Life, Executive Council
 2015 Lead Author (1/33) of the 2015 NASA Astrobiology Strategy
 2015 Workshop Organizer, Pacifichem 2015, "Applying to Graduate School in the US"
 2018 Moderator, American Physical Society 'Physics Next' workshop: Physics of Living Matter, Riverhead, Long Island
 2018-present External Advisory Board, Protometabolic Pathways (Marie Skłodowska-Curie Innovative Training Network; European Commission)
 2018-present Faculty of 1000 (Structure: RNA & DNA Section) Faculty Member

Outreach

2012-15 Intel Science Talent Search, Judge
 2017-present Regeneron Science Talent Search, Judge
 2015-present National Chemistry Week science demonstrations for local elementary school