Curriculum Vitae

Samuel H. Sternberg, Ph.D.

PROFILE

- Ph.D. level scientist with 10 years of training in molecular biology, genetics, biochemistry, and single-molecule biophysics.
- Expert in CRISPR and gene editing technology, with both academic and industry experience.
- Inventor of 7 patents in the CRISPR/gene editing space and author of 20 peer-reviewed publications in top scientific journals, with a strong record of research accomplishments.
- Author of popular science book on gene editing technologies and frequent lecturer, with excellent presentations skills and extensive experience speaking to non-specialist audiences.
- Skilled leader in directing collaborative projects, managing large multidisciplinary research teams, and executing project goals in a timely fashion.

EDUCATION

University of California, Berkeley, CA **2009 – 2014**

Ph.D. in Chemistry

Thesis: *Mechanism and engineering of CRISPR-associated endonucleases*

Advisor: Professor Jennifer A. Doudna

Columbia University, New York, NY **2003 – 2007**

B.A. in Biochemistry

GPA: 3.98/4.00, graduated *summa sum laude* with departmental honors

Advisor: Professor Ruben L. Gonzalez, Jr.

PROFESSIONAL EXPERIENCE

Scientist & Group Leader, Technology Development **Oct 2016 – present**

Caribou Biosciences, Inc., Berkeley, CA

Chief Executive Officer: Rachel Haurwitz

- Advancing novel genome engineering tools and managing five direct reports in the Technology Development group. Serving as project lead for two company projects involving eight and five team members.

Book author **July 2015 – Sept 2016**

Houghton Mifflin Harcourt, New York, NY

Senior editor: Alexander Littlefield

Title: *A Crack in Creation: Gene Editing and the Unthinkable Power to Control Evolution*

- Wrote a full-length, popular science non-fiction book on the discovery, development, and societal and ethical implications of gene editing, together with co-author Jennifer Doudna. Researched and drafted the entire book, conducted interviews, and worked with an artist on the illustrations. Book release scheduled for June 13, 2017.

Postdoctoral researcher **Jan 2015 – June 2015**

Department of Chemistry, University of California, Berkeley, CA

Principal Investigator: Professor Jennifer A. Doudna

Project: Conformational dynamics and molecular mechanism of DNA targeting by CRISPR–Cas9

- Investigated conformational changes of the Cas9 enzyme using fluorescence-based methods. Completed two projects on biophysical analyses of CRISPR–Cas9, with collaborators Dr. William Greenleaf at Stanford University, and Dr. Taekjip Ha at the University of Illinois, Urbana-Champaign (now at Johns Hopkins University).

Ph.D. researcher, thesis **June 2010 – Dec 2014**

Department of Chemistry, University of California, Berkeley, CA

Principal Investigator: Professor Jennifer A. Doudna

Project: Mechanistic studies of endonucleases involved in CRISPR–Cas adaptive immunity

- Characterized the substrate specificity of a large library of Cas ribonucleases, and developed enzymes for applications including RNA affinity purification and viral RNA diagnostics. Identified the process of target search and recognition employed by CRISPR–Cas protein–RNA complexes. Retooled CRISPR–Cas9 to bind and cleave RNA, developed a split-enzyme variant of Cas9, and contributed to the cryo-EM determination of Cas9 structures.

Ph.D. researcher, rotations **Sept 2009 – May 2010**

Department of Chemistry, University of California, Berkeley, CA

Principal Investigators: Professors Carlos Bustamante, Jennifer A. Doudna, & Andreas Martin

- Studied transcription by RNA polymerase using optical tweezers; investigated the affinities of Dicer–TRBP for pre-miRNA substrates; developed methods to study proteasome function.

Research assistant **June 2007 – Apr 2009**

Department of Chemistry, Columbia University, New York, NY

Principal Investigator: Professor Ruben L. Gonzalez, Jr.

Project: Conformational dynamics of the ribosome during termination and ribosome recycling

- Developed a single-molecule FRET assay to investigate stop codon recognition by release factors, and the dissociation of ribosomal subunits during recycling. Determined how various translation factors control inter-subunit ratcheting of the ribosome. Helped secure a major grant from the American Cancer Society based on my research.

Undergraduate researcher **May 2006 – May 2007**

Department of Chemistry, Columbia University, New York, NY

Principal Investigator: Professor Ruben L. Gonzalez, Jr.

Project: See above under “Research assistant”

HONORS AND AWARDS

Scaringe Young Scientist Award, RNA Society	**2015**
Harold M. Weintraub Graduate Student Award	**2015**
Biophysical Society Education Travel Award	**2013**
National Defense Science & Engineering Graduate Research Fellowship	**2011 – 2013**
NSF Graduate Research Fellowship	**2009 – 2014**
Graduated *summa cum laude* and with Departmental Honors, Dept. of Chemistry, Columbia University	**2007**
Outstanding Undergraduate Research Award, Dept. of Chemistry, Columbia University	**2007**
Phi Betta Kappa, Columbia University	**2007**
NSF Leadership Travel Award	**2007**
National Science Foundation (NSF) Research Experience for Undergraduates Program, Columbia University (Best student presentation)	**2006**
Irving Langmuir Scholars Program, Columbia University	**2006 – 2007**
Dean's List, Columbia University	**2003 – 2007**
Thomas M. Macioce Scholarship, Columbia University	**2003 – 2006**

PEER-REVIEWED PUBLICATIONS

Chen, J.S., Dagdas, Y.S., Kleinstiver, B.P., Welch, M.M., Harrington, L.B., **Sternberg, S.H.**, Joung, J.K., Yildiz, A., Doudna, J.A. "Enhanced proofreading governs CRISPR-Cas9 targeting accuracy." *bioRxiv* and in review (2017).

Dagdas, Y.*, Chen, J.S.*, **Sternberg, S.H.**, Doudna, J.A., Yildiz, A. "A conformational checkpoint between DNA binding and cleavage by CRISPR–Cas9." *Science Advances* **3** (2017): eaao0027.

Jackson, R.N., van Erp, P.B., **Sternberg, S.H.**, Wiedenheft, B. "Conformational regulation of CRISPR-associated nucleases." *Curr Opin Microbiol* **21** (2017): 110-119.

Boyle, E.A.*, Andreasson, J.O.L.*, Chircus, L.M.*, **Sternberg, S.H.**, Wu, M.J., Guegler, C.K., Doudna, J.A., Greenleaf, W.J. "High-throughput biochemical profiling reveals sequence determinants of dCas9 off-target binding and unbinding." *PNAS* **114** (2017): 5461-5466.

Singh, D., **Sternberg, S.H.**, Fei, J., Doudna, J.A., Ha, T. "Real-time observation of DNA recognition and rejection by the RNA-guided endonuclease Cas9." *Nat Comm* **7** (2016): 1–8.

Sternberg, S.H.*, Richter, H.*, Charpentier, E., Qimron, U. "Adaptation in CRISPR-Cas systems." *Mol Cell* **61** (2016): 797–808.

Sternberg, S.H., LaFrance, B., Kaplan, M., Doudna, J.A. "Conformational control of DNA target cleavage by CRISPR-Cas9." *Nature* **527** (2015): 110–113.

Redding, S., **Sternberg, S.H.**, Marshall, M., Gibb, B., Bhat, P., Guegler, C.K., Wiedenheft, B., Doudna, J.A., Greene, E.C. "Surveillance and processing of foreign DNA by the *Escherichia coli* CRISPR-Cas system." *Cell* **163** (2015): 854–865.

Sternberg, S.H., Doudna, J.A. "Expanding the biologist's toolkit with CRISPR-Cas9." *Mol Cell* **58** (2015): 568–574.

Baltimore, D., Berg, P., Botchan, M., Carroll, D., Charo, R.A., Church, G., Corn, J.E., Daley, G.Q., Doudna, J.A., Fenner, M., Greely, H.T., Martin, G.S., Penhoet, E., Puck, J., **Sternberg, S.H.**, Weissman, J.S., Yamamoto, K.R. "A prudent path forward for genomic engineering and germline gene modification." *Science* **348** (2015): 36–38.

Wright, A.V.*, **Sternberg, S.H.***, Taylor, D.W., Staahl, B.T., Bardales, J.A., Kornfeld, J.E., Doudna, J.A. "Rational design of a split-Cas9 enzyme complex." *PNAS* **112** (2015): 2984–2989.

O'Connell, M.R., Oakes, B.L., **Sternberg, S.H.**, East-Seletsky, A., Kaplan, M., Doudna, J.A. "Programmable RNA recognition and cleavage by CRISPR/Cas9." *Nature* **516** (2014): 263–266.

Hochstrasser, M.L.*, Taylor, D.W.*, Bhat, P., Guegler, C.K., **Sternberg, S.H.**, Nogales, E., Doudna, J.A. "CasA mediates Cas3-catalyzed target degradation during CRISPR RNA-guided interference." *PNAS* **111** (2014): 6618–6623.

Jinek, M.*, Jiang, F.*, Taylor, D.W*., **Sternberg, S.H.***, Kaya, E., Ma, E., Anders, C., Hauer, M., Zhou, K., Lin, S., Kaplan, M., Iavarone, A.T., Charpentier, E., Nogales, E., Doudna, J.A. "Structures of Cas9 endonucleases reveal RNA-mediated conformational activation." *Science* **343** (2014): 1247997-1–11.

Sternberg, S.H.*, Redding, S.*, Jinek, M., Greene, E.C., Doudna, J.A. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." *Nature* **507** (2014): 62–67.

Haurwitz, R.E., **Sternberg, S.H.**, Doudna, J.A. "Csy4 relies on an unusual catalytic dyad to position and cleave CRISPR RNA." *EMBO J* **31** (2012): 2824–2832.

Sternberg, S.H., Haurwitz, R.E., Doudna, J.A. "Mechanism of substrate selection by a highly specific CRISPR endoribonuclease." *RNA* **18** (2012): 661–672.

Wiedenheft, B., **Sternberg, S.H.**, Doudna, J.A. "RNA-guided genetic silencing systems in bacteria and archaea." *Nature* **482** (2012): 331–338.

Chakravarthy, S., **Sternberg, S.H.**, Kellenberger, C.A., Doudna, J.A. "Substrate-specific kinetics of Dicer-catalyzed RNA processing." *J Mol Biol* **404** (2010): 392–402.

Fei, J., Wang, J., **Sternberg, S.H.**, MacDougall, D.D., Elvekrog, M.M., Pulukkunat, D.K., Englander, M.T., Gonzalez, R.L. "A highly purified, fluorescently labeled in vitro translation system for single-molecule studies of protein synthesis." *Meth Enzymol* **472** (2010): 221–259.

Sternberg, S.H., Fei, J., Prywes, N., McGrath, K.A., Gonzalez, R.L. "Translation factors direct intrinsic ribosome dynamics during translation termination and ribosome recycling." *Nat Struct Mol Biol* **16** (2009): 861–868.

*These authors contributed equally.

NON-PEER-REVIEWED PUBLICATIONS

Doudna, J.A.*, **Sternberg, S.H.*** *A Crack in Creation: Gene editing and the unthinkable power to control evolution*. New York: Houghton Mifflin Harcourt, 2017.

Sternberg, S.H. "Risky Business: A research's death spurs an overhaul of safety at the UCs." *The Berkeley Science Review*, Spring 2013.

Sternberg, S.H. "Germ Warfare: Bacteria and viruses adapt for battle." *The Berkeley Science Review*, Fall 2012.

*These authors contributed equally.

PATENTS PENDING

Sternberg, S.H., Doudna, J.A. Methods of Cas9 Activation. Invention disclosure filed.

Sternberg, S.H, Doudna, J.A., LaFrance, B., Chen, J.S. Reporter Cas9 Variants and Methods of Use Thereof. PCT Patent Application No. PCT/US2016/036754. Filed June 9, 2016.

Sternberg, S.H., Doudna, J.A. Cas9 Variants and Methods of Use Thereof. PCT Patent Application No. PCT/US16/35301. Filed June 1, 2016.

Sternberg, S.H., Doudna, J.A., Wright, A.V. Heterodimeric Cas9 and Methods of Use Thereof. PCT Patent Application No. PCT/US16/12470. Filed January 7, 2016.

Doudna, J.A., **Sternberg, S.H.**, Jinek, M., Jiang, F., Kaya, E., Taylor, D.W. Cas9 Crystals and Methods of Use Thereof. PCT Patent Application No. PCT/US2014/072590. Filed December 29, 2014.

Doudna, J.A., **Sternberg, S.H.**, O'Connell, M.R., Oakes, B.L. Methods and Compositions for Modifying a Single Stranded Target Nucleic Acid. PCT Patent Application No. PCT/US2014/069730. Filed December 11, 2014.

Doudna, J.A., Jinek, M., **Sternberg, S.H**. Endoribonucleases and Methods of Use Thereof. PCT Patent Application No. PCT/US2013/045602. Filed June 13, 2013.

Gonzalez, R.L., **Sternberg, S.H**., Pulukkunat, D.K. Fluorescence-Based Approach to Monitor Release Factor-Catalyzed Termination of Protein Synthesis. U.S. Patent Application No. 13/407,438. Filed February 28, 2012.

SELECTED INVITED TALKS AND PUBLIC PRESENTATIONS

Sternberg, S.H. "Rewriting the human genome with CRISPR–Cas9." StartART: Annual REI Nursing Congress, Las Vegas, NV, USA; August 5, 2017.

Sternberg, S.H. "Editing the human genome with CRISPR–Cas9." American Academy of Dermatology 2017 meeting, New York, NY, USA; July 28, 2017.

Sternberg, S.H. "Rewriting the code of life with CRISPR technology." IVY Ideas Night, Los Angeles, CA, USA; June 22, 2017.

Sternberg, S.H. "'Spell Checking' DNA: CRISPR and gene editing." Midwest Reproductive Symposium international, Chicago, IL, USA; June 17, 2017.

Sternberg, S.H. "Mechanisms of RNA-guided DNA targeting across diverse CRISPR–Cas immune systems." Department of Microbiology and Immunology, Columbia University Medical Center, New York, NY, USA; April 17, 2017.

Sternberg, S.H. "Editing the human genome with CRISPR–Cas9." Envision Conference, Princeton, NJ, USA; December 4, 2016.

Sternberg, S.H. "Editing the genome with CRISPR–Cas9." EuropaBio 20th Year Anniversary Gala, Brussels, Belgium; November 16, 2016.

Sternberg, S.H. "Prospects of genome editing in the human germline using CRISPR–Cas9." StartART: Annual REI Nursing Congress, Las Vegas, NV, USA; August 4, 2016.

Sternberg, S.H., interview with Guy Raz. "Who are we?". *TED Radio Hour*. Podcast audio, July 15, 2016. Audio available at <http://www.npr.org/2016/07/15/485706102/how-will-cut-and-paste-technology-rewrite-our-dna>.

Sternberg, S.H. "Molecular mechanism of DNA cleavage by CRISPR–Cas9." CRISPR–Cas9: Breakthroughs and challenges, Inserm workshop, Bordeaux, France; April 6, 2016.

Sternberg, S.H. "Editing DNA with CRISPR: From GMO yogurt to designer babies." J.P. McCaskey High School, Lancaster, PA, USA; March 21, 2016.

Sternberg, S.H. "Editing the genome with CRISPR: From GMO yogurt to designer babies." Franklin & Marshall College, Lancaster, PA, USA; January 21, 2016. Video available at < https://www.youtube.com/watch?v=rQxvHBl4zDc>.

Sternberg, S.H. "Conformational control of DNA target cleavage by CRISPR-Cas9." CRISPR Summit, London, England; December 8, 2015.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Medical Research Council-Laboratory of Molecular Biology, Cambridge, England; December 7, 2015.

Sternberg, S.H. "What if we could rewrite the human genome?" TEDMED, Palm Springs, CA, USA; November 18, 2015. Video available at <https://www.youtube.com/watch?v=BSL3k9ezGoA>.

Sternberg, S.H. "DNA interrogation by the RNA-guided endonuclease Cas9." Cramer Lab Annual Workshop, Kreuth, Germany; October 2, 2015.

Sternberg, S.H. "Cracking the CRISPR code: How discoveries in bacteria transformed genetic engineering." Carl-Benz High School, Ladenburg, Germany; September 29, 2015.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Harold Weintraub Graduate Student Award Symposium, Fred Hutchinson Cancer Research Center, Seattle, WA, USA; May 1, 2015.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Department of Molecular Genetics, Weizmann Institute, Rehovot, Israel; February 10, 2015.

Sternberg, S.H. "Mechanism and engineering of the CRISPR RNA-guided endonuclease Cas9." Sackler School of Medicine, Tel Aviv University, Tel Aviv, Israel; February 9, 2015.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Antiviral Defense Mechanisms Symposium, Wageningen, Netherlands; October 8, 2014.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Systems Biology of Gene Regulation and Genome Editing, Cold Spring Harbor Asia, Suzhou, China; September 11, 2014.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Genome Engineering: Theory into Practice, Bentley University, Boston, MA, USA; June 20, 2014.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." German Cancer Research Center, University of Heidelberg, Heidelberg, Germany. May 23, 2014.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Max-Delbrück-Center for Molecular Medicine, Berlin, Germany; May 13, 2014.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Broad Institute, Massachusetts Institute of Technology, Cambridge, MA, USA; April 14, 2014.

Sternberg, S.H. "Mechanism of DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Biosciences & Biotechnology Division Seminar, Lawrence Livermore National Laboratory, Livermore, CA, USA; January 16, 2014.

Sternberg, S.H. "Mechanism of DNA interrogation by the CRISPR RNA-guided endonuclease Cas9. "Walter Lab Group Meeting, University of California, San Francisco, CA, USA; January 7, 2014.

Sternberg, S.H. "Structural and mechanistic insights into DNA targeting by the CRISPR RNA-guided endonuclease Cas9." Biology Departmental Seminar, Franklin & Marshall College, Lancaster, PA, USA; October 8, 2013.

Sternberg, S.H. "Mechanism of DNA Target Search and Cleavage by an RNA-Programmed CRISPR Endonuclease." Microbes Meeting, University of Illinois, Urbana-Champaign, IL, USA; April 4, 2013.

Sternberg, S.H. "DNA Curtains: 100s of Single Molecule Experiments at a Time." Immunology & Infectious Disease Departmental Seminar, Montana State University, Bozeman, MT, USA; February 26, 2013.

SELECTED CONFERENCE PRESENTATIONS

Sternberg, S.H. "Conformational control of DNA target cleavage by CRISPR-Cas9." CRISPR 2015 Meeting, New York, NY, USA; June 18, 2015. Oral.

Sternberg, S.H. "Rational design of split-Cas9 for genome engineering." RNA Society Meeting, Madison, WI, USA; May 29, 2015. Oral.

Sternberg, S.H. "Rational design of split-Cas9 for genome engineering." Keystone Symposium (Precision Genome Engineering and Synthetic Biology), Big Sky, MT, USA; January 12, 2015. Oral and poster.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Re-writing Genomes: A New Era in Genome Engineering, University of California, Berkeley, CA, USA; August 25, 2014. Poster.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Molecular Machines: Lessons from Integrating Structure, Biophysics and Chemistry, EMBL Heidelberg, Germany; May 18-21, 2014. Poster.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." CRISPR 2014, Berlin Germany; May 14-16, 2014. Poster.

Sternberg, S.H. "DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Keystone Symposium (Long non-coding RNAs), Santa Fe, NM, USA; March 1, 2014. Oral and poster.

Sternberg, S.H. "Mechanism of DNA interrogation by the CRISPR RNA-guided endonuclease Cas9." Bay Area Genome Engineering Forum, University of California, Berkeley, CA, USA; November 25, 2013. Oral.

Sternberg, S.H. "Mechanism of DNA Target Search and Recognition by the CRISPR RNA-guided Endonuclease Cas9." Re-writing Genomes Symposium, University of California, Berkeley, CA, USA; August 26, 2013. Poster.

Sternberg, S.H. "Mechanism of DNA Target Search and Cleavage by an RNA-Programmed CRISPR Endonuclease." Center for RNA Systems Biology, University of California, Berkeley, CA, USA; June 26, 2013. Oral.

Sternberg, S.H. "Single-molecule observation of DNA targeting and cleavage by the RNA-guided Cas9 endonuclease." RNA Society Meeting, Davos, Switzerland; June 14, 2013. Oral.

Sternberg, S.H. "Single-molecule observation of viral DNA targeting by CRISPR/Cas immune systems." Biophysical Society Meeting, Philadelphia, PA, USA; February 4, 2013. Oral.

TEACHING EXPERIENCE

Graduate student instructor, advanced general chemistry (4B) **Spring 2012**
Department of Chemistry, University of California, Berkeley, CA

- Taught weekly laboratory section associated with lecture course, including pre-lab lecture

Head graduate student instructor, general chemistry (1A) **Fall 2010**
Department of Chemistry, University of California, Berkeley, CA

- Supervised ~45 graduate student instructors assigned to individual sections, and taught weekly review session offered to ~1,500 students across three lecture courses

Graduate student instructor, general chemistry (1A) **Fall 2009**
Department of Chemistry, University of California, Berkeley, CA

- Taught weekly laboratory section associated with lecture course, including pre-lab lecture

Teaching assistant, general chemistry laboratory (C1500) **Summer 2005, Fall 2006**
Department of Chemistry, Columbia University, New York, NY

- Taught weekly laboratory section, including pre-lab lecture

PROFESSIONAL SOCIETY MEMBERSHIPS

American Association for the Advancement of Science
Biochemical Society
Biophysical Society
RNA Society

REFERENCES

Dr. Jennifer A. Doudna
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Dr. Ruben L. Gonzalez
B.A. Advisor
Columbia University, New York, NY, USA
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