

Jackson Champer

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EDUCATION

Ph.D. in Biology, City of Hope Beckman Research Institute 6/2015
 M.S. in Physics, University of California, Los Angeles 12/2006
 B.S. in Physics and Mathematics, University of Oregon 6/2004

SIGNIFICANT RESEARCH EXPERIENCE

Postdoctoral Fellow, Cornell, PIs: Phillip Messer and Andrew Clark 5/2016-Present

- Improved gene drive systems, designs and experiments.
- Collaboration with Harrington lab on mosquito gene drive.
- Computational modeling and genetic analysis of gene drives in realistic environments.

Postdoctoral Scholar, UC Riverside, PI: Omar Akbari 9/2015-3/2016

- Review article covering different gene drive systems.

Graduate Researcher, City of Hope, PI: Markus Kalkum 6/2011-6/2015

- Mass spectrometry and proteomics for antifungal vaccine development.
- Projects on detection assay for botulinum and anthrax.

Graduate Researcher, City of Hope, PI: S. Emily Wang 9/2010-12/2011

- Immunological and proteomic analysis of breast cancer extracellular matrix.

Research Technician, University of Oregon, PI: Chuck Kimmel 10/2009-3/2010

- Fluorescent reporter systems in zebrafish.

Research Technician/Supervisor, UCLA, PI: Jenny Kim 6/2008-7/2009, 8/2013-9/2014

- Immunological and proteomic analysis of *Propionibacterium acnes* phylotypes.
- Analysis of antimicrobial treatments for acne and *Staphylococcus aureus* infection.

Graduate Researcher, UCLA: PI: David Cline 6/2004-9/2004

- Simulations, design, and construction of dark matter detector.

Undergraduate Researcher, University of Oregon, PI: Russell Donnelley 8/2003-6/2004

- Propagation of vortex rings in fluid and diffusion of marker dye.

Undergraduate Researcher, Stanford University, PI: Lucy Shapiro 6/2003-7/2003

- Analysis of localization of genes in *Caulobacter crescentus*.

PUBLICATIONS

*Equal Contribution, +Mentored Student First Author

Preprints

28. **Champer J***, Kim I*+, Champer SE, Clark AG, Messer PW. Suppression gene drive in continuous space can result in unstable persistence of both drive and wild-type alleles. *bioRxiv*, September 2019.

We modeled several types of suppression gene drives in continuous space and discovered that some are unable to effectively suppress populations, despite success in panmictic populations.

27. Champer SE+, Liu C, Oh SY, Wen Z, Clark AG, Messer PW, **Champer J**. Computational and experimental performance of CRISPR homing gene drive strategies with multiplexed gRNAs. *bioRxiv*, June 2019. (under review at *Science Advances*)

We engineered several drives with up to four multiplexed gRNAs and used the resulting data in a model to predict the optimal number of gRNAs for different types of homing drives.

26. **Champer J***, Yang E*+, Lee YL, Liu J, Clark AG, Messer PW. Resistance is futile: A CRISPR homing gene drive targeting a haplolethal gene. *bioRxiv*, May 2019. (under revision at *PNAS*)

We engineered a successful population modification homing drive. It avoided resistance by targeting a haplolethal gene and containing a rescue element and by using multiplexed gRNAs.

25. **Champer J**, Lee YL, Yang E, Liu C, Clark AG, Messer PW. A toxin-antidote CRISPR gene drive system for regional population modification. *bioRxiv*, May 2019. (under revision at *Nature Communications*)

We developed a new type of CRISPR gene drive that successfully spread through large cage populations without formation of resistance alleles.

24. **Champer J**, Kim I, Champer SE, Clark AG, Messer PW. Performance analysis of novel toxin-antidote CRISPR gene drive systems. *bioRxiv*, May 2019. (under review at *BMC Biology*)

We computationally investigated a variety of new, robust gene drive designs. Some can be targeted to confined regions for both population modification and suppression.

23. **Champer J**, Zhao J, Champer SE, Liu J, Messer PW. Population dynamics of underdominance gene drive systems in continuous space. *bioRxiv*, October 2018. (under revision at *Evolutionary Applications*)

We computationally assessed underdominance systems and found that they would have greater difficulty persisting or remaining confined than previously envisioned.

Peer-Reviewed Postdoctoral Publications

22. **Champer J***, Wen Z*+, Luthra A, Reeves R, Chung J, Liu C, Lee YL, Liu J, Yang E, Messer PW, Clark AG. CRISPR Gene drive efficiency and resistance rate is highly heritable with no common genetic loci of large effect. *Genetics*, 212(1), 334-341, 2019.

We examined the effect of genetic diversity on drive performance and identified genes associated with resistance allele formation. We successfully reduced resistance rates using RNAi.

21. **Champer J**, Chung J, Lee YL, Liu C, Yang E, Wen Z, Clark AG, Messer PW. Molecular safeguarding of CRISPR gene drive experiments. *Elife*, 8, e41439, 2019.

We developed synthetic target site and split gene drives to allow safe laboratory experiments for efficient gene drives without the danger of them spreading in the wild if accidentally released.

20. Liu J⁺, **Champer J***, Liu C, Chung J, Reeves R, Lee YL, Luthra L, Clark AG, Messer PW. Maximum likelihood estimation of fitness components in experimental evolution. *Genetics*, 211(3), 1005-1017, 2019.

We developed a highly accurate and flexible method to evaluate the fitness of a particular allele based on cage studies. This will be critical for measuring gene drive fitness.

19. **Champer J***, Liu J⁺, Oh SY, Reeves R, Luthra L, Oakes N, Clark AG, Messer PW. Reducing resistance allele formation in CRISPR/Cas9 gene drive. *Proc Natl Acad Sci U S A*, 115(21), 5522-5527, 2018.

We found that multiple gRNAs reduced resistance, but by less than theoretical expectations. Modeling indicated that additional improvements would be needed for a successful drive.

18. **Champer J**, Reeves R, Oh SY, Liu C, Liu J, Clark AG, Messer PW. Novel CRISPR/Cas9 gene drive constructs reveal insights into mechanisms of resistance allele formation and drive efficiency in genetically diverse populations. *PLoS Genetics*, 13(7), e1006796, 2017.

We advanced knowledge of the mechanism of homing drives and resistance alleles in Drosophila. We showed that the resistance formation was variable in genetically diverse lines.

17. **Champer J**, Buchman A, Akbari OS. Cheating evolution: Engineering gene drives to manipulate the fate of wild populations. *Nat Rev Genet*, 17, 146-159, 2016.

Other Peer-Reviewed Publications

16. Yu Y⁺, Dunway S, **Champer J**, Kim J, Alikhan A. Changing our microbiome: Probiotics in dermatology. *Br J Dermatol*, 2019.

15. Champer M, Wong AM, **Champer J***, Brito IL, Messer PW, Hou JY, Wright JD. The role of the vaginal microbiome in gynaecological cancer. *BJOG*, 125(3), 309-315, 2018.

14. **Champer J**, Ito JI, Clemons KV, Stevens DA, Kalkum M. Proteomic analysis of pathogenic fungi reveals highly expressed conserved cell wall proteins. *J. Fungi*, 2(1), 6, 2016.

13. Yu Y⁺, **Champer J***, Agak GW, Kao S, Modlin RL, Kim J. Different *Propionibacterium acnes* phylotypes induce distinct immune responses and express unique surface and secreted proteomes. *J Invest Dermatol*, 136(11), 2221-2228, 2016.

12. Yu Y⁺, **Champer J**, Kim J. Analysis of the surface, secreted, and intracellular proteome of *Propionibacterium acnes*. *EuPA Open Proteom*, 9, 1-7, 2015.

11. Yu Y⁺, **Champer J**, Beynet DP, Kim J, Friedman AJ. The role of the cutaneous microbiome in skin cancer: Lessons learned from the gut. *J Drugs Dermatol*, 14(5), 461-465, 2015.
10. Yu Y⁺, **Champer J**, Garbán H, Kim J. Typing of *Propionibacterium acnes*: A review of methods and comparative analysis. *Br J Dermatol*, 172(5), 1204-1209, 2015.
9. Schmidt NW, Agak GW, Deshayes S, Yu Y, Blacker A, **Champer J**, Xian W, Kasko AM, Kim J, Wong GC. PenTobra: An aminoglycoside with robust antimicrobial & membrane activity against *Propionibacterium acnes*. *J Invest Dermatol*, 135(6), 1581-1589, 2015.
8. Taylor EJM⁺, Yu Y, **Champer J**, Kim J. Resveratrol demonstrates antimicrobial effects against *Propionibacterium acnes*. *Dermatol Ther*, 4, 249-257, 2014.
7. Chow A, Zhou W, Liu L, Fong MY, **Champer J**, Van Haute D, Chin AR, Ren X, Gugiu BG, Meng Z, Huang W, Ngo V, Kortylewski M, Wang SE. Macrophage immunomodulation by breast cancer-derived exosomes requires Toll-like receptor 2-mediated activation of NF- κ B. *Sci Rep* 4, 5750, 2014.
6. Lehrnbecher T, Kalkum M, **Champer J**, Tramsen L, Schmidt S, Klingebiel T. Immunotherapy in invasive fungal infection-focus on invasive aspergillosis. *Curr Pharm Des*, 19(20), 3689-3712, 2013.
5. **Champer J**, Diaz-Arevalo D, Champer M, Hong TB, Wong M, Shannahoff M, Ito JI, Clemons KV, Stevens DA, Kalkum M. Protein targets for broad-spectrum mycosis vaccines: quantitative proteomic analysis of *Aspergillus* and *Coccidioides* and comparisons with other fungal pathogens. *Ann N Y Acad Sci*, 1273, 44-51, 2012.
4. **Champer J**, Patel J, Fernando N, Salehi E, Wong V, Kim J. Chitosan against cutaneous pathogens. *AMB Express*, 3(1), 37, 2013.
3. Friedman AJ, Phan J, Schairer DO, **Champer J**, Qin M, Pirouz A, Blecher-Paz K, Oren A, Liu PT, Modlin RL, Kim J. Antimicrobial and anti-inflammatory activity of chitosan-alginate nanoparticles: a targeted therapy for cutaneous pathogens. *J Invest Dermatol*, 133(5), 1231-1239, 2013.
2. Chandra M, Zang S, Li H, Zimmerman L, **Champer J**, Chow A, Zhou W, Tsuyada A, Yu Y, Gao H, Ren X, Lin RJ, Wang SE. Nuclear translocation of type I TGF- β receptor confers a novel function in RNA splicing. *Mol Cell Biol*, 32(12), 2183-2195, 2012.
1. Bungau C, Camanzi B, **Champer J**, Chen Y, Cline DB, Luscher R, Lewin JD, Smith PF, Smith NJT, Wang H. Monte Carlo studies of combined shielding and veto techniques for neutron background reduction in underground dark matter experiments based on liquid noble gas targets. *Astroparticle Physics*, 23, 97-115, 2005.

Patents

Champer J, Messer PW, Clark AG. Additional toxin-antidote gene drives. Provisional Patent filed 3 May 2019.

Champer J, Messer PW, Clark AG. Toxin-antitoxin gene drives. Provisional Patent filed 30 October 2018.

Yu Y⁺, **Champer J**, Kim J. Compositions and Methods for Treating Skin and Mucus Membrane Diseases. US 20170065647. Published November 2015.

Taylor E⁺, **Champer J**, Kim J. Treatment of inflammatory and infectious skin disorders. US 20140018437 A1. Published January 2014.

POSTDOCTORAL PRESENTATIONS

Champer J, Yang E, Kim I, Lee YL, Champer SE, Clark AG, Messer PW. “Experimental and computational tests of CRISPR toxin-antidote gene drive strategies” *Entomological Society of America, Conference*, 2018. (talk scheduled for November 2019)

Yang E⁺, **Champer J**, Liu J, Lee YL, Liu C, Clark AG, Messer PW. “A CRISPR homing gene drive targeting a haplolethal gene with rescue averts resistance.” *Entomology Society of America, Conference*, 2019. (talk scheduled for November 2019)

Champer J, Yang E, Kim I, Liu J, Wen Z, Clark AG, Messer PW. “Gene drive strategies for control of the sea lamprey.” *Sea Lamprey International Symposium*, 2019. (invited talk)

Champer J, Yang E, Kim I, Liu J, Wen Z, Clark AG, Messer PW. “Experimental and computational tests of new gene drive strategies.” *EMBO Vector Conference*, 2019. (talk)

Champer J, Yang E, Kim I, Lee YL, Champer S, Clark AG, Messer PW. “Computational and experimental tests of new CRISPR gene drive strategies.” *Society for the Study of Evolution Annual Meeting*, 2019. (invited talk)

Champer J. “Experimental and computational tests of novel CRISPR gene drive strategies.” *University of Melbourne*, 2019. (invited seminar)

Champer J, Clark AG, Messer PW. “Can CRISPR gene drive succeed in natural populations?” *Entomological Society of America, Joint Annual Meeting*, 2018. (invited talk)

Champer J, Chung J, Liu C, Luthra L, Reeves R, Lee YL, Liu J, Wen, Z, Yang E, Clark AG, Messer PW. “A genome-wide association study to identify genetic factors affecting resistance allele formation in CRISPR gene drives.” *Genetics Society of America PEQG Conference*, 2018. (poster)

Liu J⁺, **Champer J**, Liu C, Chung J, Reeves R, Luthra L, Lee YL, Clark AG, Messer PW. “Maximum likelihood estimation of sex-dependent fitness costs of a *yellow* mutant allele in *Drosophila melanogaster*.” *Genetics Society of America, 59th Annual Drosophila Research Conference*, 2018. (talk)

Champer J, Chung J, Liu C, Luthra L, Reeves R, Lee YL, Liu J, Wen, Z, Yang E, Clark AG, Messer PW. “A genome-wide association study to identify genetic factors affecting resistance allele formation in CRISPR gene drives.” *Genetics Society of America, 59th Annual Drosophila Research Conference*, 2018. (talk)

Champer J, Reeves R, Oh SY, Liu C, Liu J, Clark AG, Messer PW. “CRISPR gene drives with reduced resistance allele formation.” *Cold Spring Harbor Laboratory Meetings, Genome Engineering: The CRISPR-Cas Revolution*, 2017. (talk)

Champer J, Reeves R, Oh SY, Liu C, Liu J, Clark AG, Messer PW. “Resistance allele formation and genetic diversity in *Drosophila* CRISPR/Cas9 gene drives.” *Genetics Society of America, 58th Annual Drosophila Research Conference*, 2017. (poster)

RESEARCH SUPPORT**Active Support**

F32AI138476 Champer (PI) 4/2018 - Present
 NIH/NIAID ~\$250,000
 Dynamics of gene drives in natural populations

R21AI130635 Messer, Clark (PIs), Champer (key personnel)* 9/2017 - Present
 NIH/NIAID ~\$250,000
 Improved CRISPR gene drive systems with reduced resistance allele formation
 *drafted the grant and responsible for allocating most of the funding.

Pending Support

K22 (GRANT12903019) Champer (PI) (submitted July 2019/Cycle II)
 NIH/NIAID ~\$250,000
 Engineering and modeling improved CRISPR gene drive systems

DP2 (611019) Champer (PI) (submitted October 2019/Cycle III)
 NIH/NIAID ~\$1,500,000
 Toxin-antidote gene drives for confined population modification or suppression

TEACHING EXPERIENCE

Guest Lecturer, Cornell University 9/2017, 11/2018

- Lectures for the “Population Genetics” upper-division class.

Teaching Fellow, City of Hope Beckman Research Institute 3/2014-4/2014

- Lectures and evaluation for the intensive “Current Topics in Biology” graduate class.

Tutor and Academic Mentor, UCLA/Los Angeles 1/2007-8/2013

- Acted as mentor to medical, undergraduate, and high school students.
- Worked with individuals and small groups of students in precalculus, calculus, statistics, physics, general chemistry, organic chemistry, microbiology, genetics, molecular biology, ecology, animal behavior, conservation biology, and social science classes.

Teaching Assistant, UCLA 9/2004-12/2006

- Laboratory and discussion sections of undergraduate physics classes.
- Revised the laboratory manual for UCLA’s “physics for life-science students” course.

RESEARCH STUDENTS MENTORED

Current Students at Cornell University: Emily Yang, Isabel Kim, Lin Xie, Matt Metzloff, Nathan Oakes (graduate), Sam Champer, Sandra Lapinska, Suh Yeon Oh.

Cornell University: Anisha Luthra, Anna Langmuller (graduate), Chen Liu, Hongya Zhu (graduate), Jingxian Liu, Joan Chung, Joanna Zhao, Phoebe Conley, Riona Reeves, Wei Cheng, Yineng Xu (graduate), Yoo Lim Lee, Zhaoxin Wen.

University of California, Riverside: Jennifer Shyong, Kenneth Truong.

University of California, Los Angeles: Elaheh Salehi, Julie Patel, Nathalie Fernando, Sam Ngo, Victoria Wong, Yang Yu (graduate).

City of Hope Beckman Research Institute: Jason Yu, Mayyen Wong, Miriam Champer, Molly Shannahoff.

OTHER EXPERIENCE

Workshops: FNIH Data Needs and Assay Design for Decision Making on Gene Drive-Modified Mosquitoes (2019), ILSI Gene Drive Modeling Conference (2019)

Journal Referee: Nature Communications (2019), Proceedings of the Royal Society B (2019), PeerJ (2019), Bioscience (2019), PLOS Genetics (2018), Evolutionary Applications (2017), Journal of Theoretical Biology (2017), European Journal of Dermatology (2015), Infection, Genetics and Evolution (2015)

Other Referee: National Carp Control Plan for Australia “Synergistic genetic biocontrol options for common carp (*Cyprinus carpio*)” (2019), United Nations Environment Programme: Frontiers, Emerging Issues of Environmental Concern, Synthetic Biology (2018)

Membership: Entomology Society of America (2019), Society for the Study of Evolution (2019), Genetics Society of America (2016), American Association for the Advancement of Science (2015), American Society for Mass Spectrometry (2012)

HONORS AND AWARDS

City of Hope Beckman Research Institute: Chu Fellowship (2014), Scholarly Award (2011)
University of California, Los Angeles: Tutor of the Year Award (2009), Teaching Excellence Award (2004-2006)

University of Oregon: Honors in Physics (2004), Academic Scholarships (2002-2004)
Lane Community College: Geology Excellence Award (2002)