

# Geoffrey D Hannigan

## *Curriculum Vitae*

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Website: <http://microbiology.github.io>

## **EDUCATION**

### **University of Pennsylvania**

**Ph.D. | 2015**

School of Medicine

Program: Cell & Molecular Biology

Concentration: Gene Therapy & Vaccines

Certificate: HHMI Med-Into-Grad Scholar

### **University of Minnesota Duluth**

**B.S. | 2011**

College of Science and Engineering

Major: Cell & Molecular Biology

Minors: Chemistry, Philosophy

## **RESEARCH & RELATED EXPERIENCE**

### **Executive Director ( June 2022 – Present )**

Merck Digital Sciences Studio

Cambridge, MA

Topics: *Co-Founder, Startup Accelerator, Digital Health, Entrepreneurship, Venture Capital*

### **Principal Scientist ( May 2020 – Present )**

Merck Research Labs, Exploratory Science Center

Systems Biology Research Group

Cambridge, MA

Topics: *Microbiome, Immunology, Machine Learning, Natural Products, Bio-manufacturing*

### **Associate Principal Scientist ( July 2017 – May 2020 )**

Merck Research Labs, Exploratory Science Center

Systems Biology Research Group

Cambridge, MA

Topics: *Microbiome, Immunology, Machine Learning, Natural Products, Bio-manufacturing*

### **Postdoctoral Research Fellow ( October 2015 – July 2017 )**

University of Michigan, Medical School

Dr. Patrick Schloss (Principle Investigator)

Topics: *Gut Microbiome, Virome, Virus-Host Interactions, Bioinformatics, Machine Learning*

### **Scientific Advisory Board Member ( April 2015 – July 2017 )**

SmartPhage, Inc  
San Francisco, CA  
*Custom Phage Company*

### **PhD Candidate ( 2012 – 2015 )**

University of Pennsylvania, School of Medicine  
Dr. Elizabeth Grice, Ph.D. (Principal Investigator)  
Topics: *Skin Microbiome & Virome, Bioinformatics, Dermatologic Disease Etiology*

### **Undergraduate Researcher ( 2009 – 2011 )**

University of Minnesota Duluth, Department of Biology  
Dr. John Dahl, Ph.D. (Principal Investigator)  
Topics: *Microbial Ecology, Microbiology, Mycobacteria, Bacteriophages, Biochemistry*

### **Undergraduate Research Fellow ( Summer 2010 )**

Mayo Clinic Graduate School, Department of Virology and Gene Therapy  
Dr. Roberto Cattaneo, Ph.D. (Principal Investigator)  
Dr. Patricia Devaux, Ph.D. (Research Advisor)  
Topics: *Measles Virus Evasion of Immune System, Molecular Biology of Measles Infections*

### **Undergraduate Researcher ( 2008 – 2009 )**

University of Minnesota Duluth, School of Medicine  
Dr. Jean Regal, Ph.D. (Principal Investigator)  
Topics: *Mechanisms of Lung Injury, Asthma, Allergies, Immunology*

## **PUBLICATIONS**

- Gokul Swaminathan, Michael Citron, Jianying Xiao, James E Norton Jr, Abigail L Reens, Begüm D Topçuoğlu, Julia M Maritz, Keun-Joong Lee, Daniel C Freed, Teresa M Weber, Cory H White, Mahika Kadam, Erin Spofford, Erin Bryant-Hall, Gino Salituro, Sushma Kommineni, Xue Liang, Olga Danilchanka, Jane A Fontenot, Christopher H Woelk, Dario A Gutierrez, Daria J Hazuda, **Geoffrey D Hannigan**. 2021. Vaccine Hyporesponse Induced by Individual Antibiotic Treatment in Mice and Non-Human Primates Is Diminished upon Recovery of the Gut Microbiome. *Vaccines*. doi: 10.3390/vaccines9111340
- David Prihoda, Julia M Maritz, Ondrej Klempir, David Dzamba, Christopher H Woelk, Daria J Hazuda, Danny A Bitton, **Geoffrey D Hannigan**. 2021. The application potential of machine learning and genomics for understanding natural product diversity, chemistry, and therapeutic translatability. *Natural Product Reports*. doi: 10.1039/D0NP00055H
- Naila Gulzar, Jonathon Keeney, Jack B Baker, Ondrej Klempir, **Geoffrey D Hannigan**, Danny Asher Bitton, Julia M Maritz, Charles Hadley Samler King, Janisha A Patel, Paul A Duncan, Raja Mazumder. 2021. BioCompute Objects to communicate a viral detection pipeline with potential for use in a regulatory environment. *bioRxiv*. doi: 10.1101/2021.10.19.465010

- Hagan AK, Lesniak NA, Balunas MJ, Bishop L, Close WL, Doherty MD, Elmore AG, Flynn KJ, **Hannigan GD**, Koumpouras CC, Jenior ML, Kozik AJ, McBride K, Rifkin SB, Stough JMA, Sovacool KL, Sze MA, Tomkovich S, Topcuoglu BD, and Schloss PD. 2020. Ten Simple Rules to increase computational skills among biologists with Code Clubs. *PLoS Computational Biology*. doi: 10.1371/journal.pcbi.1008119
- Hannigan GD**, Prihoda D, Palicka A, Soukup J, Klempir O, Rampula L, Durcak J, Wurst M, Kotowski J, Chang D, Wang R, Piizzi G, Hazuda DJ, Woelk CH, Bitton DA. 2019. A Deep Learning Genome-Mining Strategy For Biosynthetic Gene Cluster Prediction. *Nucleic Acids Research*. doi: 10.1093/nar/gkz654.
- Hannigan GD**, Duhaime MB, Ruffin IV MT, Koumpouras CC, and Schloss PD. 2018. Diagnostic Potential & the Interactive Dynamics of the Colorectal Cancer Virome. *mBio*. doi: 10.1128/mBio.02248-18.
- Hannigan GD**, Duhaime MB, Koutra D, and Schloss PD. 2018. Biogeography and Environmental Conditions Shape Bacteriophage-Bacteria Networks Across the Human Microbiome. *PLoS Computational Biology*. doi: 10.1371/journal.pcbi.1006099.
- Bartow-McKenney C, **Hannigan GD**, Horwinski J, Hesketh P, Horan A, Mehta S, Grice EA. 2018. The Microbiota of Traumatic, Open Fracture Wounds is Associated with Mechanism of Injury. *Wound Repair Regen*. doi: 10.1111/wrr.12642.
- Hannigan GD**, Zheng Q, Meisel JS, Minot S, Bushman FD, Grice EA. 2017. Evolutionary and Functional Implications of Hypervariable Loci Within the Skin Virome. *PeerJ*. doi: 10.7717/peerj.2959.
- Meisel JS, **Hannigan GD**, Tyldsley AS, SanMiguel AJ, Hodkinson BP, Zheng Q, Grice EA. 2016. Skin microbiome characterizations are biased by experimental design. *Journal of Investigative Dermatology*. doi: 10.1016/j.jid.2016.01.016.
- Hannigan GD**, Meisel JS, Tyldsley AS, Zhang Q, Hodkinson BP, SanMiguel AJ, Minot S, Bushman FD, Grice EA. 2015. The human skin dsDNA virome: Topographical and temporal diversity, genetic enrichment, and its dynamic associations with the host microbiome. *mBio*. 6(5):e01578-15. doi: 10.1128/mBio.01578-15.
- Hannigan GD**, Hodkinson BP, McGinnis K, Tyldsley AS, Anari JB, Horan AD, Grice EA, Mehta S. 2014. Culture-independent pilot study of microbiota colonizing open fractures and association with severity, mechanism, location, and complication from presentation to early outpatient follow-up. *J Orthop Res*. 32(4):597-605. doi: 10.1002/jor.22578.
- Hannigan GD**, Pulos N, Grice EA, Mehta S. 2014. Current concepts and ongoing research in the prevention and treatment of open fracture infections. *Advances in Wound Care*. doi: 10.1089/wound.2014.0531.

**Hannigan GD**, Weiner DB. 2014. Current Progress in DNA Vaccine Cancer Therapy. *Advanced Textbook on Gene Transfer, Gene Therapy and Genetic Pharmacology*. D. Scherman, Editor. Imperial College Press.

**Hannigan GD**, Grice EA. 2013. Microbial ecology of the skin in the era of metagenomics and molecular microbiology. *Cold Spring Harb Perspect Med*, Fiona Watt and Tony Oro, Editors. doi: 10.1101/cshperspect.a015362.

**Hannigan GD**, Krivogorsky B, Fordice D, Welch JB, Dahl JL. 2013. *Mycobacterium minnesotense* sp. nov., a photochromogenic bacterium isolated from sphagnum peat bogs. *International journal of systematic and evolutionary microbiology* 63: 124-128.

## **PATENTS**

**Hannigan GD**, Prihoda D, Soukup J, Woelk CH, Bitton DA. 2018. *Identifying Biosynthetic Gene Clusters*. 62/779.697.

## **PUBLISHED SOFTWARE**

**Hannigan GD**, Loesche MA, Hodkinson BP, Mehta S and Grice EA. **Creator** (cre), **Author** (aut). patPRO: Visualizing Temporal Microbiome Data. <http://CRAN.R-project.org/package=patPRO>

Oksanen J, et al. **Contributor** (ctb). Vegan: R Package for Community Ecologists. <http://CRAN.R-project.org/package=vegan>

## **COMPUTATIONAL SKILLS**

Bash Scripting, R, Perl, Python, Julia, MySQL, Neo4j/Cypher, GNU Make, Unix/Linux, Machine Learning, Microbiome processing (e.g. Qiime/Mothur), Genomic processing (Bowtie, Blast, etc), RNA-seq Processing & Analysis (e.g. DESeq2, edgeR), RHEL, CentOS, Ubuntu, Mac OS, Windows OS, Windows Office, Adobe Creative Suite.

## **AWARDS & COMPETITIVE GRANTS**

**Merck Exploratory Science Center Team Award**

2018

**Merck PASRD Award for Fostering Collaboration & Driving Results**

2018

**University of Michigan Molecular Mechanisms in Microbial Pathogenesis Fellowship (MMMP)**

2016 - 2017

**National Defense Science & Engineering Graduate Fellowship (NDSEG)**

2012 - 2015

**University of Pennsylvania Biomedical Graduate School TRE Award**

2014-2015

**University of Pennsylvania Biomedical Graduate School Student Travel Award**  
2014  
**University of Minnesota Undergraduate Research Opportunity Program Grant**  
2011  
**Mayo Clinic Summer Undergraduate Research Fellowship**  
2010  
**University of Minnesota Undergraduate Research Opportunity Program Grant**  
2009

## **SELECT PUBLISHED ABSTRACTS & INVITED PRESENTATIONS**

### *Oral Presentations*

**Hannigan GD.** *BGCs and the Microbiome.* Cambridge Startup Public Presentation. September 09, 2019. Cambridge, MA.

**Hannigan GD.** *Extracting Functional Microbiome Information Through Deep-Learning.* MicroSeminar Series (Available on YouTube). July 25, 2019. Cambridge, MA.

**Hannigan GD,** Prihoda D, Palicka A, Soukup J, Klempir O, Rampula L, Durcak J, Wurst M, Kotowski J, Chang D, Wang R, Piizzi G, Hazuda DJ, Woelk CH, Bitton DA. *A Deep Learning Genome-Mining Strategy Improves Biosynthetic Gene Cluster Prediction.* Merck Discovery, Pre-Clinical, and Early Development (DPED) Symposium. [INTERNAL]. April 24, 2019.

**Hannigan GD.** *Keynote Speaker: Colorectal Cancer Classification Using The Gut Virome.* October 23, 2017. Chicago, IL.

**Hannigan GD,** Duhaime MB, Ruffin IV MT, Koumpouras CC, and Schloss PD. *Viral and Bacterial Communities of Colorectal Cancer.* American Society for Microbiology General Meeting. June 5, 2017. New Orleans, Louisiana.

**Hannigan GD,** Meisel JS, Tyldsley AS, Zheng Q, Hodkinson BP, SanMiguel AJ, Minot S, Bushman FD, Grice EA. *The Human Skin dsDNA Virome: Topographical and Temporal Diversity, Functionality, and its Dynamic Associations with the Host Microbiome.* 5<sup>th</sup> International Human Microbiome Congress. April 2, 2015. Luxembourg, Luxembourg.

**Hannigan GD,** Meisel JS, Tyldsley AS, Zheng Q, Hodkinson BP, SanMiguel AJ, Minot S, Bushman FD, Grice EA. *The Human Skin dsDNA Virome: Topographical and Temporal Diversity, Functionality, and its Dynamic Associations with the Host Microbiome.* University of Pennsylvania Dermatology Research Seminar. April 7, 2015. Philadelphia, PA.

**Hannigan GD,** Meisel JS, Tyldsley AS, Zheng Q, Hodkinson BP, SanMiguel AJ, Minot S, Bushman FD, Grice EA. *The Human Skin dsDNA Virome: Topographical and Temporal Diversity, Functionality, and its Dynamic Associations with the Host Microbiome.* University of Pennsylvania Dermatology Basic Research Symposium. October 9, 2014. Philadelphia, PA.

**Hannigan GD**, Hodkinson BP, McGinnis K, Tyldsley AS, Horan AD, Mehta S, Anari JB, Grice EA. *The Dynamic Microbiomes Associated with Traumatic Wound Healing*. 5th Annual HHMI Med Into Grad Symposium. June 14-15, 2013. New Haven, CT.

*Poster Presentations*

**Hannigan GD**, Duncan P, Klempir O, Maritz J, Sze M, Bitton D, Woelk CH, Benetti L, Hazuda DJ. [INTERNAL]. Merck Boston Science Symposium. November 15, 2019.

**Hannigan GD**, Swaminathan G, Aliprantis A, Liu W, Liang X, Norton J, Citron M, Xiao J, Cho C, Kang J, Datta S, Kommineni S, Danilchanka O, Woelk CH, Espeseth A, Gutierrez D, Hazuda DJ. [INTERNAL]. Merck Early Development Course. October 14, 2019.

Liang X, Swaminathan G, Perera S, Kopinja J, Citron M, Xiao J, **Hannigan GD**, Norton J, Kommineni S, Woelk CH, Gutierrez D, Hazuda DJ. *Gut microbiome perturbation by oral antibiotics leads to immune hypo-responsiveness*. Keystone Symposia: Microbiome: Therapeutic Implications. October 6, 2019.

Swaminathan G, **Hannigan GD**, Citron M, Xiao J, Norton J, Lee KJ, Liang X, Kommineni S, Gutierrez D, Hazuda DJ. *Gut microbiome perturbation by oral antibiotics leads to vaccine hypo-responsiveness*. Cold Spring Harbor Microbiome Meeting. July 1, 2019.

**Hannigan GD**, Prihoda D, Palicka A, Soukup J, Klempir O, Rampula L, Durcak J, Wurst M, Kotowski J, Chang D, Wang R, Piizzi G, Hazuda DJ, Woelk CH, Bitton DA. *A Deep Learning Genome-Mining Strategy Improves Biosynthetic Gene Cluster Prediction*. American Society for Microbiology. June 29, 2019.

**Hannigan GD**, Prihoda D, Palicka A, Soukup J, Klempir O, Rampula L, Durcak J, Wurst M, Kotowski J, Chang D, Wang R, Piizzi G, Hazuda DJ, Woelk CH, Bitton DA. *A Deep Learning Genome-Mining Strategy Improves Biosynthetic Gene Cluster Prediction*. Merck Data Science Symposium [INTERNAL]. March 23, 2019.

**Hannigan GD**, Prihoda D, Palicka A, Soukup J, Klempir O, Rampula L, Durcak J, Wurst M, Kotowski J, Chang D, Wang R, Piizzi G, Hazuda DJ, Woelk CH, Bitton DA. *A Deep Learning Genome-Mining Strategy Improves Biosynthetic Gene Cluster Prediction*. MIT Microbiome Symposium. March 07, 2019.

**Hannigan GD**, Duhaime MB, Ruffin IV, MT, Schloss, PD. *Unraveling the Role of the Gut Virome in Colorectal Cancer*. 6<sup>th</sup> International Human Microbiome Congress. November 9-11, 2016.

**Hannigan GD**, Meisel JS, Tyldsley AS, Zheng Q, Hodkinson BP, SanMiguel AJ, Minot S, Bushman FD, Grice EA. *The Human Skin dsDNA Virome: Topographical and Temporal Diversity, Functionality, and its Dynamic Associations with the Host Microbiome*. University of Michigan ASM Branch Meeting. October 23-24, 2015. Ann Arbor, MI.

**Hannigan GD**, Meisel JS, Tyldsley AS, Zhang Q, Hodkinson BP, SanMiguel AJ, Grice EA. *Topographical and Temporal Diversity of Healthy Human Skin Phage and Bacterial Communities*. 2014 Molecular Genetics of Bacteria and Phages Meeting. August 5-9, 2014. Madison, WI.

**Hannigan GD**, Hodkinson BP, McGinnis K, Tyldsley AS, Horan AD, Mehta S, Anari JB, Grice EA. *The Dynamic Microbiomes Associated with Traumatic Wound Healing*. University of Pennsylvania Center for Musculoskeletal Disorders Scientific Symposium. November 13, 2013. Philadelphia, PA.

Devaux P, **Hannigan GD**, Hudacek AW, Cattaneo R. *Characterization of glycine-rich region involved in the interaction between measles virus P protein and STAT1*. 30<sup>th</sup> Annual Meeting of the American Society for Virology. July 16-20, 2011. Minneapolis, MN.

**Hannigan GD**, Dahl JL. *Mycobacterium arupense in Northern Minnesota Bogs*. 16<sup>th</sup> Annual University of Minnesota Duluth Undergraduate Research & Artistic Showcase. April 15, 2011. Duluth, MN.

#### *Panel Presentations*

**Harvard Boston Bacterial Meeting | Student Career Panel (2020)**

**Harvard Boston Bacterial Meeting | Student Career Panel (2019)**

**University of Pennsylvania Cell & Molecular Biology Symposium | Career Panel (2019)**

**Harvard Boston Bacterial Meeting | Student Career Panel (2018)**

#### **FORMAL TEACHING EXPERIENCE**

Workshop Leader, Intro to Bioinformatics, Linux, and High Performance Computing, May 2018

Workshop Leader, Introduction to R Programming, October 2017

Workshop Leader, Lab Notebooks and Project Management with GitHub, October 2016

Workshop Leader, Introduction to R Programming, September 2016

Workshop Leader, Introduction to Human Virome Analysis, June 2015

Workshop Leader, Introduction to R Programming, March 2015

Workshop Leader, Introduction to Bioinformatics & Programming, September 2014

Teaching Assistant, Undergraduate Genetics Supplemental Instruction. 2010.

Tutor, Undergraduate Mathematics. 2009.

#### **MEMBERSHIP IN PROFESSIONAL SOCIETIES**

**American Society for Microbiology**

Member, 2013-Present

**International Society for Viruses of Microorganisms**

Member, 2013-Present

## **OUTREACH & LEADERSHIP**

**Boston Microbiome Meetup Organizer** (April 2018 - Present)

**Annual NDSEG Fellowship Review Panelist** (2016 - Present)

**Research Blogger at “Prophage”** (2013 – Present)

**Ann Arbor R User Group Organizer** (2016 - 2017)

**Co-Leader of Data Analysis Reading Group** (2016 - 2017)

**Program Representative in Biomedical Graduate Student Association** (2013 – 2015)

**Co-founder and Leader of Microbiome Graduate School Journal Club** (2012 – 2015)

## **REFERENCES**

Available Upon Request