Nathaniel D. Chu

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SUMMARY

I am a data scientist with experimental and computational expertise in integrating diverse data types from clinical and environmental sources. As a team member, I have experience teaching open communication, facilitative leadership, and negotiation by focusing on shared goals over conflicting methods. In conversation, I am quick to get excited about solving problems in underserved areas of health and sustainability.

EDUCATION

Ph.D., Microbiology 2014–2019
Department of Biological Engineering, Massachusetts Institute of Technology**,** MA
Advisor: Dr. Eric Alm
Thesis: Ecological and evolutionary dynamics of clinical fecal microbiota transplants

ScB, Biology, honors, *magna cum laude*. 2008–2012
Brown University**,** RI
Thesis: Phylogenomics in a non-model marine invertebrate

RESEARCH

Human Microbiome & Genomics Lab, Graduate Student, multiple projects 2014–2019
Massachusetts Institute of Technology, MA
Advisor: Dr. Eric Alm

Systematic analysis of inflammatory bowel disease patients receiving fecal microbiota transplants

- Led analysis and generation of datasets from stool, blood, and biopsies: 16S, metagenomics, bacterial isolates, whole-genome sequencing, viral sequencing, single-cell RNA sequencing, immune repertoire sequencing, immunoglobulin-A sequencing, and metabolomics
- Developed new computational analyses for strain identification in Python and R, focusing on creating user-friendly, well-documented tools
- Analyzed whole genomes from bacterial isolates and assembled genomes and genes of interest from longitudinal metagenomic data
- Coordinated a large collaboration with academic, clinical, nonprofit, and industry partners.
- Worked with clinicians to design a clinical trial and obtain regulatory approval
- Two publications in preparation

Time-series dynamics of the adaptive immune system

- Applied analytical methods from microbial ecology to understand the longitudinal dynamics of the adaptive immune system (T-cell receptors) in healthy subjects
- Advised a graduate student and worked with industry partners
- One publication in review

Effects of oxygen exposure on fecal microbiota transplant engraftment in C. difficile patients

- Coordinated the design, regulatory approval, sampling, data generation, and analysis of a clinical trial in collaboration with clinicians and industry partners
- Developed new experimental and computational tools to quantify living and dead microbes in a fecal sample
- Led a team including a graduate student, undergraduate student, and industry employee
- One publication in print, one publication in preparation

Novel mechanisms of hypermutation in environmental and clinical bacteria

- Used experimental evolution and analysis of whole-genome sequencing to identify a prophage-driven hypermutation mechanism present in diverse bacteria
- One publication in print

Microbiome signatures of type II diabetes development in a Mexican population

- Collaborated with clinicians and professors from two Mexican institutions to analyze and interpret clinical and microbiome data
- Established sampling and analysis protocols with local researchers
- Advised an undergraduate student to apply machine learning tools to microbiome data
- One publication in preparation

Marine Microbiology & Genomics Lab, U.S. Fulbright Fellow, multiple projects 2012–2014
Smithsonian Tropical Research Institute, Bocas del Toro, Panama &
Marine Science Center, Northeastern University, MA
Advisor: Dr. Steven Vollmer, Dr. Andrew Altieri

Identifying determinants of coral reef microbial community structure

- Led an international research effort to sample microbes on different coral species in various locations
- Coordinated a SCUBA field-research team including local Panamanian volunteers
- Analyzed resulting metagenomic data
- One publication in print, one publication in preparation.

Using genomics to uncover source-sink population dynamics in the Atlantic sea scallop

- Collaborated with North Atlantic fisherman to obtain samples during fishing voyages, accompanying multiple commercial fishing trips
- Assembled a draft genome and transcriptome to study populations dynamics

Marine Genomics Lab, Research Associate 2011–2012
Marine Science Center, Northeastern University, MA
Advisor: Dr. Steven Vollmer and Dr. Geoffrey Trussell

Phylogenomic analyses of a North Atlantic snail

- Revealed biogeographic population structure and gene expression responses to predators
- Two publications in print

Marine Ecology Lab, Research Technician 2008–2010
Brown University, Providence, RI
Advisor: Dr. Heather Leslie

Effects of climate change and nutrient loading on coastal marine ecosystems

- Designed and built an electric and plumbing system to manipulate temperature and nutrients in small intertidal mesocosms

PUBLICATIONS (* corresponding author, † equal contribution)

Chu ND, Crothers, JW, [. . .] Clish CB, Moses PL, Xavier RJ, Alm EJ. (in prep) Colonization of microbes, virus, and molecules alter immunological trajectories of inflammatory bowel disease patients receiving fecal microbiota transplants.

Diener C, **Chu ND**, Zhong VL, Matus MG, Alm EJ, Resendis O, Guardado R. (in prep) Gut-microbiome composition, glucose metabolism, lifestyle and cardio-metabolic risk in a large, treatment-naive Mexican cohort.

Crothers JW, **Chu ND**, [. . .] Budd RC, Kassam Z, Alm EJ, Mawe GM, Moses PL. (submitted) T-cell response to fecal microbiota transplant corresponds to clinical outcome: report of a randomized control trial. *Gastroenterology.*

Dunphy CM, Gouhier TC, **Chu ND**, Vollmer SV. (in review) Structure and stability of the coral microbiome in space and time. *Scientific Reports*.

Chu ND, Bi HS, Emerson RO, Sherwood AM, Birnbaum ME, Robins HS, Alm EJ. (in review) Longitudinal immunosequencing in healthy people reveals persistent T cell receptors rich in public receptors. *BMC Immunology*. *bioarxiv*. DOI: 10.1101/262667

Chu ND†, Clarke SA†, Timberlake S, Polz MF, Grossman AD, Alm EJ. (2017) A mobile element in *mutS* drives hypermutation in a marine *Vibrio*. *mbio*.

Chu ND, Smith MB, Perrotta AR, Kassam Z, Alm EJ. (2017) Profiling living bacteria informs preparation of fecal microbiota transplantations. *PLoS One*.

Chu ND*, Vollmer SV. (2016) Caribbean corals house shared and host-specific microbial symbionts over time and space. *Environmental Microbiology Reports*.

Chu ND*, Miller LP, Kalusiak ST, Trussell GC, Vollmer SV. (2014) Thermal stress and predation risk trigger distinct transcriptomic responses in the intertidal snail *Nucella lapillus*. *Molecular Ecology*.

Chu ND*, Kalusiak ST, Trussell GC, Vollmer SV. (2014) Phylogenomic analyses reveal latitudinal population structure and polymorphisms in heat stress genes in the North Atlantic snail *Nucella lapillus*. *Molecular Ecology*.

Chu ND. Creature Cast podcast: "Sea Stars," 2010. Nature Publishing Group. http://creaturecast.org/archives/1360-creaturecast-sea-stars

GRANTS & AWARDS

NSF Graduate Research Fellowship, 2014, National Science Foundation, $138,000

Schoettler Scholarship, 2014-2015, Massachusetts Institute of Technology, $72,488

U.S. Fulbright Award, 2012–2013, Bocas del Toro, Panama, $19,825

Smithsonian Tropical Research Institute Short-term Fellowship, 2012–2013

Research-at-Brown Grant, 2011, Brown University, $300

Undergraduate Teaching and Research Award, 2009, Brown University, $3,000

Robert C. Byrd Honors Scholarship, 2008–2012, Washington State, $6,000

TEACHING & MENTORSHIP

Bioengineering Undergraduate Research Advisor, multiple projects 2017–2018
SuperUROP Program, Massachusetts Institute of Technology, MA
Donor identity and oxygen exposure alter bacterial engraftment in fecal microbiota transplants
- Advised MIT undergraduate in computational analyses of 16S and metagenomic data

Using machine learning to uncover gut microbiome patterns in Mexicans with type II diabetes
- Advised MIT undergraduate to apply machine learning to 16S data and present results to international collaborators

Ecology Teaching Assistant 2015
Massachusetts Institute of Technology, MA
Designed and gave multiple in-class lectures, taught recitations and laboratory classes

Leadership Development Instructor and Expedition Leader 2010–2012
YMCA Camp Orkila, Eastsound, WA
Designed and taught curricula on leadership, facilitation, conflict resolution, and communication to groups of teens during multiweek sea kayaking expeditions

PROFESSIONAL REFERENCES

Dr. Eric J. Alm (PhD advisor), Karl Van Tassel Career Development Associate Professor of Biological Engineering, Director of the Center for Microbiome Informatics and Therapeutics, and Associate Member of the Broad Institute, Massachusetts Institute of Technology. 77 Massachusetts Ave, Cambridge, MA 02139, ejalm(at)mit(dot)edu

Dr. Jessica W. Crothers (clinical collaborator)**,** Clinical Fellow, Department of Pathology, Brigham and Women's Hospital and Harvard Medical School. Relationship: clinical collaborator. 75 Francis St, Boston, MA 02115, jwcrothers(at)bwh(dot)harvard(dot)edu

Dr. Mark B. Smith (industry collaborator), CEO and co-founder of Finch Therapeutics Group, co-founder of OpenBiome. 200 Inner Belt Rd, Somerville, MA 02143, mark(at)finchtherapeutics(dot)com

Dr. Steven V. Vollmer (research advisor), Associate Professor of Biology and Director of Bioinformatics, Department of Marine and Environmental Sciences, Northeastern University. Relationship: research advisor. Marine Science Center, 430 Nahant Road, Nahant, MA 01908, s.vollmer(at)neu(dot)edu

Vivian Zhong (research advisee), Undergraduate student, Department of Biological Engineering, Massachusetts Institute of Technology. 77 Massachusetts Ave, Cambridge, MA 02139, vivzhong(at)mit(dot)edu

LANGUAGES

Human: English (native), Spanish (limited working proficiency, once fluent)
Computer: Python, R, Unix Bash and environment

INVITED TALKS & PRESENTATIONS

Longitudinal immunosequencing in healthy individuals reveals persistent T cell receptors rich in public receptors, 2018, *Keystone Symposia: Translational Systems Immunology*, Snowbird, UT (talk)

Using propidium monoazide sequencing (PMA-seq) to develop data-driven best practices in fecal microbiota transplantations, 2015, *IDWeek*, San Diego, CA (poster)

Ecoturismo y su impacto en los arrecifes de corales, 2013, Autoridad de Tourismo de Panamá, Bocas del Toro, Panama

Entendiendo el colapso de los arrecifes Carribeños con la ciencia molecular, 2013, STRI Bocas del Toro., Panama Teachers workshop from David, Panama

Biodiversidad microbiana y la salud de arrecifes, 2013, STRI Bocas del Toro & University of Panama Biology Program, Panama

PROFESSIONAL DEVELOPMENT, OUTREACH, & CLUBS

StartMIT, 2019, MA. 3-week course in building and developing start-ups

MIT Science Policy Initiative Bootcamp, 2019, MA. A one-week intensive course on science policy

MIT Science Policy Initiative Coordinator, 2017–, MA. Advocate for investment in science and technology research as well as greater transparency in the science community. Engage with local, state, and federal lawmakers

MIT STEM Outreach Program Mentor, 2014–2017, MA. Mentor students grades 6–9 in science and technology classes and activities

MIT Biotech Group, 2014–, MA. Accelerating biotechnology solutions by bringing together MIT faculty and students with scientists in the private sector

MIT Outing Club President, Mountaineering Chair, Winter School Leader, Rock Climbing Leader, Ice Climbing Leader, Hiking Leader, 2014–, MA

Fulbright Alumni Ambassador, 2014–, WA. Help lead Fulbright outreach programs with potential applicants and current foreign Fulbright students