A fundamental question in mucosal immunology is why some dietary proteins induce lifelong tolerance while others drive potent allergic responses. Current models focus on host susceptibility, yet fail to explain why immune responses diverge across different food antigens encountered under similar physiological conditions. A major barrier to progress is the implicit assumption that protein biochemistry dictates immune outcomes, despite the fact that purified antigens are typically non-immunogenic without added exogenous adjuvant signals.

We hypothesize that food contains adjuvant signals that instruct the development of allergic versus tolerogenic immune responses to dietary antigens. Our preliminary data demonstrate that food context can dictate both the magnitude and type (Treg/Th2/etc.) of antigen-specific T cell responses. Further, while studies of adjuvant activity have largely focused on innate immune cells, our findings suggest that antigen uptake across the intestinal epithelium is an equally sensitive determinant of immune outcome. We propose that these adjuvant signals arise from diverse sources, including intrinsic components of the food matrix (e.g., dietary lipids and carbohydrates), as well as exogenous molecules introduced through microbial contamination or food processing. Notably, for antigens with defined ligand-binding pockets, we further hypothesize that small molecule adjuvants may directly associate with dietary proteins, thereby altering antigen stability, epithelial transport, and downstream immune recognition.

The technical execution of this proposal is supported by a robust foundation of experience related to immune interpretation of dietary antigens. These projects use unique T cell labeling reagents and cell lines specific to dietary antigens that were developed by our lab. Further, this work is facilitated by our interdisciplinary lab research team, combining experts in immunology, analytical chemistry, and plant biology. By leveraging this collective expertise, we will systematically evaluate how molecular context drives the development of allergy or tolerance responses toward food.

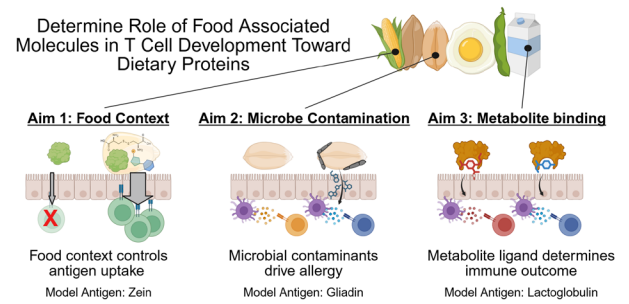

Figure 2: Summary of Aims

Aim 1: Determine the grain-derived molecules and corresponding sensing mechanisms that are necessary for antigen uptake and development of oral tolerance to prolamin antigens

We previously discovered that the maize protein zein is recognized by intestinal Tregs. Unexpectedly, the food context of zein is critical for the development of this Treg population. Across multiple corn preparations, Zein Treg induction correlates with molecular complexity. Further, using novel *in vivo* and intestinal organoid models, we discovered that intestinal uptake correlates with differential Treg induction and that intestinal M cells are responsible for zein uptake. While the role of M cells in immune tolerance has been controversial, our data provide antigen-specific evidence of a role in Treg induction. In this aim, we will use zein as a model antigen to identify specific dietary molecules that regulate M cell antigen transport and establish the relationship between M cells and oral tolerance to food antigens.

Aim 2: Identify how food-associated microbial signals regulate allergy toward dietary proteins

We hypothesize that microbial products present on food act as physiologic adjuvants that shift immune responses from tolerance to allergy. Focusing on *Fusarium*-contaminated wheat, we will test whether fungal metabolites enhance allergic sensitization to gliadin. We will compare sterile versus contaminated food preparations to assess effects on intestinal antigen uptake, antigen-specific T cell polarization and IgE antibody responses. Further, we will use metabolomics and fractionation approaches to identify candidate bioactive molecules. Our gliadin-reactive T cell line will be used to decipher mechanism of action. These studies will establish whether naturally occurring foodborne signals are sufficient to drive allergic priming.

Aim 3: Identify allergen-small molecule binding pairs and determine their impact on allergy

Many food allergens are annotated to play lipid or small molecule binding roles. Further, diverse classes of small molecules are immune stimulatory. Yet few pairs of allergens and small molecule ligands have been described. We will identify ligands associated with major allergens using biochemical and analytical approaches, and test their functional impact using antigen-specific T cell systems and *in vivo* allergy models we developed. By comparing ligand-bound versus ligand-free forms of the same antigen, we will determine how small molecule association alters antigen uptake, innate activation, and downstream T cell responses.

Impact: This work will establish a new conceptual framework in which dietary antigens are interpreted by the immune system in the context of co-delivered adjuvant signals. By identifying the molecular drivers of tolerance versus sensitization, this project will open new avenues for allergy prevention, including rational removal of pro-allergic signals and engineering of tolerogenic food matrices.

JAMIE BLUM

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EDUCATION AND WORK EXPERIENCE

Assistant Professor Salk Institute for Biological Studies 2025-Present

Adjunct Assistant Professor University of California at San Diego 2026-Present

Postdoctoral Training LSRF fellow at Stanford University/HHMI, Chemical Engineering 2021-2025
Advisor: Dr. Elizabeth Sattely

PhD NSF GRFP fellow at Cornell University, Molecular Nutrition August 2021
Dissertation: "Intracellular and Circulating Metabolic Mediators of Skeletal Muscle Progenitor Cell Function"
Advisor: Dr. Anna Thalacker-Mercer

BS Cornell University, Human Biology May 2016

PUBLICATIONS

ORCID ID: https://orcid.org/0000-0002-2168-5390
*Denotes equal authorship contribution
#Denotes corresponding or co-corresponding authorship

Published:

1. **Blum, J.E.#**, Kong, R., Schulman, E.A., Chen, F.M., Upadhyay, R., Romero-Meza, G., Littman, D.R., Fischbach, M.A., Nagashima, K.#, Sattely, E.S.# **(2026).** Identification and characterization of dietary antigens in oral tolerance. *Science Immunology*. https://doi.org/10.1126/sciimmunol.aeb4684
***Featured on journal cover**

2. Xue, S., Benvie, A., **Blum, J.E.**, Cosgrove, B.D., Thalacker-Mercer, A., Berry, D. **(2026).** Suppressing PDGFRβ signaling enhances myocyte fusion to promote skeletal muscle regeneration. *JCI.* doi: 10.1172/JCI188272

3. Qu, Y., Edwards, K., Li, M., Williams, M., Liu, Y., Tsai, P., Cheng, C., **Blum, J.**, Acor, N., Oshoe, T., Walter, C., Thirumalaikumar, V., Thalacker-Mercer, A., Skyricz, A., Barrow, J. **(2025)**. Small molecule oxybutynin rescues proliferative capacity of complex III-defective MPCs. *AJP-Cell Physiology.* https://doi.org/10.1152/ajpcell.00141.2025

4. Nagashima, K., Zhao, A., Atabakhsh, K., Bae, M., **Blum, J.E.,** Weakley, A., Jain, S., Meng, X., Cheng, A.G., Wang, M., Higginbottom, S., Dimas, A., Murugkar, P., Sattely, E.S., Moon, J.J., Balskus, E.P., Fischbach, M.A. (**2023**). Mapping the T cell repertoire to a complex gut bacterial community. *Nature*. doi: 10.1038/s41586-023-06431-8.

5. Fiddler, J.L., **Blum, J.E.**, Heyden, K.E., Castillo, L.F., Thalacker-Mercer, A.E., Field, M.S. (**2023**). Impairments in SHMT2 expression or cellular folate availability reduce oxidative phosphorylation and pyruvate kinase activity. *Genes & Nutrition*. https://doi.org/10.1186/s12263-023-00724-3

6. **Blum, J.E.**, Gheller, B.J, Benvie, A., Field, M.S., Panizza, E., Vacanti, N.M., Berry, D., Thalacker-Mercer, A. (**2021**). Pyruvate Kinase M2 supports muscle progenitor cell proliferation but is dispensable for skeletal muscle regeneration after injury. *Journal of Nutrition*. doi.org/10.1093/jn/nxab251

***Recognized as the Science Unbound Foundation's Best Paper (2021) by a UAB, Indiana University, or Columbia University investigator in obesity/nutrition**

7. Fiddler, J.L., Xiu, Y., **Blum, J.E**., Lamarre, S.G., Stabler, S.P., Thalacker-Mercer, A.E., Field, M.S. (**2021**). Reduced shmt2 expression impairs mitochondrial folate accumulation and respiration, and leads to uracil accumulation in mouse mitochondrial DNA. *Journal of Nutrition*. doi.org/10.1093/jn/nxab211
8. **Blum, J.**, Epstein, R., Watts, S., Thalacker-Mercer A. (**2021**). Importance of Nutrient Availability and Metabolism for Skeletal Muscle Regeneration. *Frontiers in Physiology.* https://doi.org/10.3389/fphys.2021.696018
9. Thalacker-Mercer, A., **Blum, J.E.** (**2021**). Discovery and application of dietary compounds to optimize human health, a focus on skeletal muscle regeneration. *Current Opinion in Biotechnology*. doi: 10.1016/j.copbio.2021.04.003
10. Chen, H.*, **Blum, J.E**.*, Thalacker-Mercer, A., Gu, Z. (**2021**). Impact of the whole genome duplication event on PYK activity and effects of a PYK1 mutation on metabolism in S. cerevisiae. *Frontiers in Molecular Biosciences*. doi.org/10.3389/fmolb.2021.656461
11. Nichenko, A.S., Sorensen, J.R., Southern, W.M., Qualls, A.E., Schifino, A.G., McFaline-Figueora, J., **Blum, J.E.**, Thalakcer-Mercer, A.E., Greising, S.M., Call, J.A. (**2021**). Lifelong ULK1-mediated autophagy deficiency in muscle induces mitochondrial dysfunction and contractile weakness. *International Journal of Molecular Sciences*. doi.org/10.3390/ijms22041937
12. Gheller, B.J., **Blum, J.E.**, Lim, E.W., Handzlik, M.K., Fong, E.H.H., Ko, A., Khanna, S., Gheller, M.E., Bender, E.L., Alexander, M.S., Stover, P.J., Field, M.S., Cosgrove, B.D., Metallo, C.M., Thalacker-Mercer, A.E. (**2021**). Extracellular serine and glycine are required for mouse and human skeletal muscle stem and progenitor cell function. *Molecular Metabolism.* doi.org/10.1016/j.molmet.2020.101106
13. Gheller, B.J., **Blum, J.E.**, Fong, H., Malysheva, O., Cosgrove, B.D., Thalacker-Mercer, A.E. (**2020**). A defined N6-Methyladenosine (m6A) profile conferred by METTL3 regulates muscle stem cell state transitions. *Cell Death Discovery*. doi.org/10.1038/s41420-020-00328-5
14. Ntemiri, A., Ghosh, T.S., Gheller, M.E., Tran, T.T.T., **Blum, J.E.**, Pellanda, P., Vickova, K., Neto, M., Howell, A., Thalacker-Mercer, A., O'Toole, P.W. (**2020**). Whole blueberry and isolated polyphenols modulate specific gut microbes in an in vitro colon model and in human consumers. *Nutrients.* doi:10.3390/nu12092800
15. **Blum, J.E.**, Gheller, B.J., Hwang, S., Bender, E., Gheller, M., Thalacker-Mercer, A.E. (**2020**). Consumption of a blueberry enriched diet by women for 6 weeks alters determinants of human muscle progenitor cell function. *Journal of Nutrition.* doi.org/10.1093/jn/nxaa190
    ***Editor's Choice Article**
16. Gheller, B. J.*, **Blum, J.***, Soueid-Baumgarten, S., Bender, E., Cosgrove, B. D., Thalacker-Mercer, A. (**2019**). Isolation, Culture, Characterization, and Differentiation of Human Muscle Progenitor Cells from the Skeletal Muscle Biopsy Procedure. *Journal of Visualized Experiments.* doi:10.3791/59580
17. Gheller, B., **Blum, J.,** Merritt, E., Cummings, B., Thalacker-Mercer, A. (**2019**). Peptide YY (PYY) is expressed in human skeletal muscle tissue and expanding human muscle progenitor cells. *Frontiers in Physiology*. doi: 10.3389/fphys.2019.00188

RESEARCH FELLOWSHIP FUNDING

Life Science Research Foundation (LSRF) 2022-2025
HHMI Awardee of LSRF
'Contribution of Plant Metabolites to Allergy and Oral Tolerance'

National Science Foundation Graduate Research Fellowship 2017-2021
'Effects of Mitochondrial Biogenesis on Cellular Regeneration in Human Progenitor Cells'

Human Ecology Undergraduate Research Grant 2015
'Role of Leucine in Skeletal Muscle Insulin Resistance'

HONORS AND AWARDS

Selected participant in the National Graduate Student Symposium at St. Jude [Cancelled due to COVID-19]	2020
University of Florida Outstanding Poster Award	2019
American Society for Nutrition Trainee Travel Award	2018
Division of Nutritional Sciences Research Symposium Poster Contest Winner	2018
Florence Halpern Award for Leadership in Community Service	2016
Human Ecology Degree Marshal (Graduated in top 2)	2016
Robinson Award for Academic Excellence	2016

ORAL PRESENTATIONS

National and International Conference or Symposium Presentations:

1. Molecular Determinants of Airway and Food Allergies. La Jolla Immunology Conference. La Jolla, CA. October 2026.
2. Food Allergy from the Plant Perspective. Annual Meeting of the Phytochemical Society of North America. Madison, WA. June 2026.
3. From Protein to Plate: Dietary Context Directs Intestinal Treg Responses. Food Allergy Gordon Research Conference. Ventura, CA. January 2026.
4. Let's Talk Tolerance: Mapping dietary antigens that underlie intestinal immune tolerance. Life Sciences Research Foundation Annual Meeting. Boston, MA. May 2025.
5. Identification and characterization of dietary tolerogens. Food Allergy Gordon Research Symposium. Ventura, CA. January 2024.
6. Identification of antigens and tolerizing components from commonly consumed foods. Food Allergy Gordon Research Symposium. Oxnard, CA. November 2022.
7. Pyruvate kinase M2 (PKM2) regulates muscle progenitor cell proliferation, oxidative stress, and metabolism. St. Jude National Graduate Student Symposium. Memphis, TN. [Cancelled due to COVID-19]. March 2020.
8. SIRT5 is associated with myogenic differentiation. Advances in Skeletal Muscle Biology in Health and Disease Conference. Gainesville, FL. March 2019.
9. Characterizing the Role of PKM2 in Muscle Progenitor Cells. First International Conference on Precision Nutrition and Metabolism in Public Health and Medicine, Crete, Greece. September 2018.

Invited Seminar Presentations:

1. Let's Talk Tolerance: Mapping dietary antigens that underlie intestinal immune tolerance. Salk Institute. San Diego, CA. February 13 2025.
2. Let's Talk Tolerance: Mapping dietary antigens that underlie intestinal immune tolerance. University of California at Davis Nutrition Department. Davis, CA. January 28 2025.
3. Let's Talk Tolerance: Mapping dietary antigens that underlie intestinal immune tolerance. Northeastern University Department of Chemistry and Chemical Biology and Institute for Plant-Human Interactions. Virtual. January 22 2025.
4. Let's Talk Tolerance: Mapping dietary protein-immune cell interactions in the intestine. Molecular, Cell, and Developmental Biology and Institute for Biomolecular Design and Discovery. Yale University. New Haven, CT. January 8 2025.

Local Presentations:

1. Molecular Determinants of Airway and Food Allergies. NOMIS Center Symposium in Conceptual Immunology and Mel Cohn Lecture. Salk Institute. March 30th, 2026.
2. From Protein to Plate: Dietary Context Directs Intestinal Treg Responses. Presented at the Program in Immunology PI Slam. UCSD. December 2nd, 2025.

3. Food Allergy from the Plant Perspective. Presented at the Plant Bio Seminar Series. UCSD. November 14th, 2025.
4. Protein features and contextual signals shaping food allergy and tolerance. Presented at the Salk Annual Faculty Retreat. Anza Borrego CA. October 22nd, 2025.
5. Let's Talk Tolerance: Mapping dietary antigens that underlie intestinal immune tolerance. Presented at the Stanford Autoimmune and Allergy Supergroup. Stanford University. April 5th, 2024.
6. Let's Talk Tolerance: Mapping dietary protein-immune cell interactions in the gut. Presented at the Synthetic Biology Community Talks. Stanford University. November 14th, 2023.
7. Intracellular and circulating metabolic mediators of muscle progenitor cell proliferation. Presented at the Stem Cell Work in Progress Group. Cornell University. September 15th, 2020.
8. Role of SIRT5 in Myogenesis. Presented at the Sirtuin Focus Group Seminar. Cornell University, May 31st, 2019.
9. Function, Regulation and Relevance of PKM2 in Muscle Progenitor Cells. Presented at the Molecular Nutrition Focus Group Seminar. Cornell University, March 27th, 2019.
10. Age-related differences in the proliferative response of muscle stem cells to acute TNF alpha treatment. Presented at Aging Inflammation Metabolism and Stress (AIMS) Meeting, Cornell University, December 13th, 2017.

POSTER PRESENTATIONS

Conference Presentations:

1. Chang, B., Chou, T., Kong, R., Schulman, E., Sattely, E. **Blum, J.** (2026, January). From Protein to Plate: Dietary Context Directs Intestinal Treg Responses. Poster Presentation at the Food Allergy Gordon Research Conference. Ventura, CA.
2. **Blum, J.**, Kong, R., Schulman, E., Nagashima, K., Fischbach, M., Sattely, E. (2024, April). Identification and characterization of dietary tolerogens. Poster Presentation at the Life Sciences Research Foundation Annual Meeting. Chicago, IL.
3. **Blum, J.,** Kong, R., Schulman, E., Nagashima, K., Fischbach, M., Sattely, E. (2024, January). Identification and characterization of dietary tolerogens. Poster Presentation at the Food Allergy Gordon Research Conference. Ventura, CA.
4. **Blum, J.,** Schulman, E., Nagashima, K., Kong, R., Fischbach, M., Sattely, E. (2023, April). Identification of antigens from commonly consumed foods. Poster Presentation at the Life Sciences Research Foundation Annual Meeting. San Diego, CA.
5. **Blum, J.,** Nagashima, K., Fischbach, M., Sattely, E. (2022, November). Identification of antigens and tolerizing components from commonly consumed foods. Poster Presentation at the Food Allergy Gordon Research Conference. Oxnard, CA.
6. **Blum, J.,** Wengier, D., Nagashima, K., Fischbach, M., Sattely, E. (2022, June). Plant chemistry in allergy and oral tolerance. Poster Presentation at Food Allergy Science Initiative Symposium. Boston, MA.
7. **Blum, J**., Gheller, B., Field, M., Thalacker-Mercer A. (2021, March) Role of Pyruvate Kinase M2 in Muscle Progenitor Cells. Metabolic Decisions in Development and Disease Keystone Conference. Online.
8. **Blum, J.**, Gheller, B., Yi, J., Thalacker-Mercer, A. (2019, June). Glycolytic and Mitochondrial Metabolism are Essential for Muscle Progenitor Cell Proliferation and Impacted by Pyruvate Kinase M2. Poster Presentation at Nutrition 2019 Conference. Baltimore, MD. Curr Dev Nutr, 3 supplement 1. DOI: 10.1093/cdn/nzz044.p08-135-19
9. **Blum, J.,** Roman, H., Thalacker-Mercer, A. (2017, April). Fn14 Expression is Lower in Female Compared to Male Skeletal Muscle, Independent of Adult Age. Poster Presented at the EB Conference, Chicago, IL. FASEB J, 31, 713.13.
10. **Blum, J.,** Roman, H., Thalacker-Mercer, A. (2017, April). Short-term Inflammation Increases Proliferative Capacity of Human Skeletal Muscle Progenitor Cells from Young and Old Female Donors. Poster Presented at the EB Conference, Chicago, IL. FASEB J, 31, 1082.10.
11. **Blum, J.**, Gheller, B., Roman, H., Thalacker-Mercer, A. (2016, April). Effects of PYY on IL-6 Signaling in Primary Human Myotubes. Poster presented at the EB Conference, San Diego, CA. FASEB J, 30, 969.11.

Local Symposia Presentations:

1. **Blum, J.**, Gheller, B., Gheller, M., Hwang, S., Bender, E., Thalacker-Mercer, A. (2020, August). Serum factors important for proliferation of muscle progenitor cells show person-to-person variation and are modifiable by dietary intervention. Presentation at Cornell University Stem Cell Symposium. Online.
2. **Blum, J.**, Gheller, B., Fernandez, I., Epstein, R., Weiss, R., Thalacker-Mercer, A. (2019, October). Role of SIRT5 in Muscle Progenitor Cells. Poster Presentation at the Precision Nutrition Symposium. Ithaca, NY.
3. **Blum, J.**, Gheller, B., Yi, S.E., Thalacker-Mercer, A. (2019, June). Glycolytic and Mitochondrial Metabolism are Essential for Muscle Progenitor Cell Proliferation and Impacted by Pyruvate Kinase M2. Poster Presentation at the Stem Cell Program Symposium. Ithaca, NY.
4. **Blum, J.**, Chon, J., Le, H., Gheller, B., Yi, J., Thalacker-Mercer, A. (2018, June). Determining the Role of PKM2 in Muscle Progenitor Cells. Poster presented at the Nutrition Graduate Student Organization Poster Competition, Ithaca, NY.
5. **Blum, J.**, Chon, J., Le, H., Gheller, B., Yi, J., Thalacker-Mercer, A. (2018, June). Determining the Role of PKM2 in Muscle Progenitor Cells. Poster presented at the Nutrition Graduate Student Organization Poster Competition, Ithaca, NY.
6. **Blum, J.,** Gheller, B., Roman, H., Thalacker-Mercer, A. (2017, July). Satellite Cells From Older Adults Display An Impaired Proliferative Response To Short Term TNF alpha Treatment. Poster Presented at the Stem Cell Program Symposium, Ithaca, NY.

TEACHING EXPERIENCE

Cornell University, Ithaca NY August 2016-May 2019

- Teaching assistant for NS3310: Nutrient Metabolism
- Teaching assistant for NS2450: Social Science Perspectives on Food and Nutrition
- Teaching assistant for NS5410/NS5411: Applied Anatomy and Physiology
- Guest lecture 'The TCA Cycle' in NS3200: Biochemistry
- Guest lecture 'Muscle Tissue' in NS5410: Applied Anatomy and Physiology
- Guest lecture 'Epithelial Tissue' in NS5410: Applied Anatomy and Physiology
- Duties included holding weekly office hours, writing exams, leading review sessions
- Was exposed to problem-based learning modalities and traditional style lecturing

Kaplan Test Prep, Ithaca NY June 2016- January 2017

- Led GRE and MCAT prep courses
- Provided individual tutoring

Cornell CHEM1007: General Chemistry Tutor August 2013-May 2016

- Held weekly office hours (6 hours/week during academic year and 50-60 hours/week during summer 2014)
- Provided multiple approaches to problem solving and catered to individual learning needs
- Collaborated with other tutors and instructors

PROFESSIONAL TRAINING

Agilent qTOF Training
Agilent Technologies, Boston MA, August 2022

Responsible conduct of research training session

- Student Discussion Leader in 2020
- Participant in 2019

Cornell University Teaching Conference, October 2018

Writing boot camp, Cornell University, August 2017

PROFESSIONAL SERVICE

Salk Board Meeting Research Presentation, 2026
High School Science Day Keynote Talk, 2026
Salk's Year of Brain Health Panel Discussion Member, 2026
Chalk Talk Workshop, Panelist, 2025

Salk Science at the Seaside, Oral Presentation Judge 2025
Foothill Science Learning Institute Summer Student Mentor, June-August 2022
Expanding your Horizons, Workshop Leader, 2020
Expanding your Horizons, Workshop Leader, 2019
Expanding your Horizons, Workshop Leader, 2018
Expanding your Horizons, Participant Buddy, 2017
Expanding your Horizons, Participant Buddy, 2016
Cayuga Medical Center Volunteer, January 2015 - May 2016
Cornell University Orientation Supervisor, January 2016
Cornell University Orientation Supervisor, August 2015
Cornell University Orientation Supervisor, August 2014
Cornell University Orientation Leader, August 2013
PROSPER Intern through Cornell Cooperative Extension, May- August 2013

TRAINEE MENTORSHIP AND LAB MEMBERS

Graduate Student Trainees

- Blair Chen, Biological Sciences (2025-present)

Postdoctoral Fellow Trainees

- Tsui-Wen (Tracy) Chou (2025-present)

Staff Scientist Lab Members

- Henry Le (2026-present)

Undergraduate Trainees

- Andrew Morrison (2025-present), work study program
- Keyla Juarez, (2026-present)

Rotation Students (Graduate Program)

- Sophia Warlof, Bioengineering (Fall 2025)

REFERENCES

Dr. Elizabeth Sattely, Postdoctoral Advisor
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Dr. Anna Thalacker-Mercer, Predoctoral Advisor
Email: athalack@uab.edu | Phone: 250-935-9143

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Email: Dan.Littman@nyulangone.org | Phone: 212-263-7520

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