AI Skills to Solutions

Training Needs and Food Safety Applications

Ryan Blaustein, PhD
Assistant Professor
University of Maryland
Department of Nutrition and Food Science

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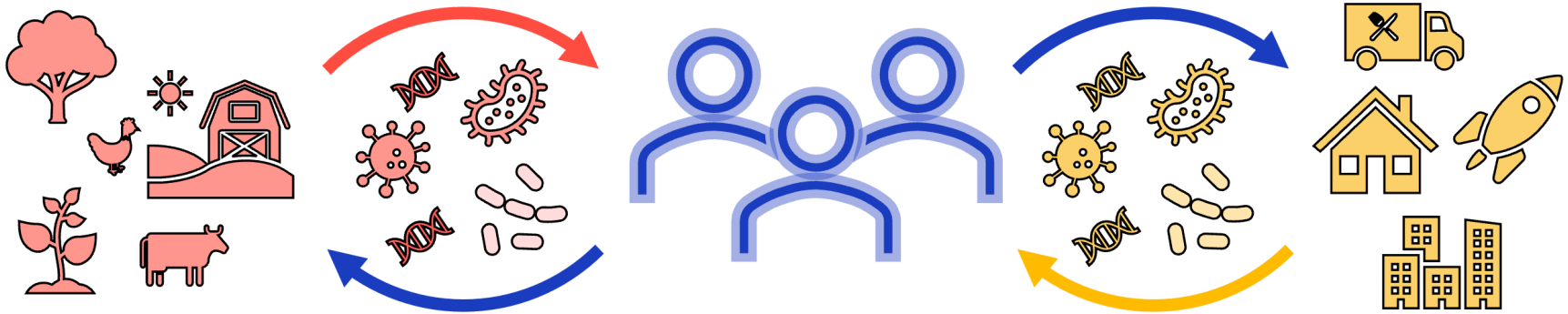
Microbial Ecology of Food & Agriculture Systems



COLLEGE OF AGRICULTURE & NATURAL RESOURCES

DEPARTMENT OF NUTRITION AND FOOD SCIENCE

- *Microbial evolution*
- *Microbial interactions*
- *Applied interventions*

AI in Agriculture: Faculty Cluster Hire

Themes in AI:

- Machine learning models
- Precision agriculture (animal feeding, irrigation scheduling)
- Internet of Things (IoT) sensors
- Automation and robotics (production line)
- Computer vision for pest management
- Animal behavior through video imaging/spectra
- Weather and climate assessment
- Remote sensing, UAV (drone)

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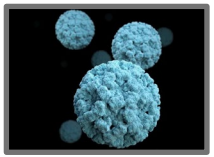
Latest Reports

Worldwide: Lake et al. 2026, *The Lancet*

WHO estimates of the global, regional, and national burden of 42 foodborne infectious and chemical hazards, 2000–21: an updated data synthesis

Robin J Lake, Brecht Devleesschauwer*, Shannon E Majowicz, Lucy J Robertson, Lea Sletting Jakobsen, Antonio Agudo, Sara M Pires, Martyn D Kirk, Elaine Scallan Walter, Karen H Keddy, Carlotta di Bari, Louise Vaes, Arie H Havelaar, Charlee Roberts, Tesfaye Gobena, Mirjam E Kretzschmar, Gabriela F Nane, Sandra Hoffmann, Lapo Mughini-Gras, Banchob Sripa, Kunihiro Kubota, Luria Leslie Founou, Li Bai, Mohammed Al Huthiel, Tety Rachmawati, Teresa Estrada-Garcia, Ashok Kumar, Fadi Al Natour, Steven Jaffee, Spencer Henson, Luc Ingenbleek, Richard Kumapley, Elaine Borghi, Yuki Minato, on behalf of the WHO Foodborne Disease Burden Epidemiology Reference Group for 2021–25†*

- 866 M illnesses
- 1.5 M deaths
- $310+ B economic damages



USA: Scallan Walter et al. 2025, *Emerg Infect Dis*

RESEARCH

Foodborne Illness Acquired in the United States—Major Pathogens, 2019

Elaine J. Scallan Walter, Zhaohui Cui, Reese Tierney, Patricia M. Griffin, Robert M. Hoekstra, Daniel C. Payne, Erica B. Rose, Carey Devine, Angella Sandra Namwase, Sara A. Mirza, Anita K. Kambhampati, Anne Straily, Beau B. Bruce

- 7 major pathogens
- 9.9 M illnesses
- 53,000 hospitalizations
- 931 deaths

"Access to safe and nutritious food is an important determinant of health"

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US-CDC

Monday, June 22, 2026 Subscribe

IFT's Food Technology

Reimagining Food Safety in a Time of Rapid Change

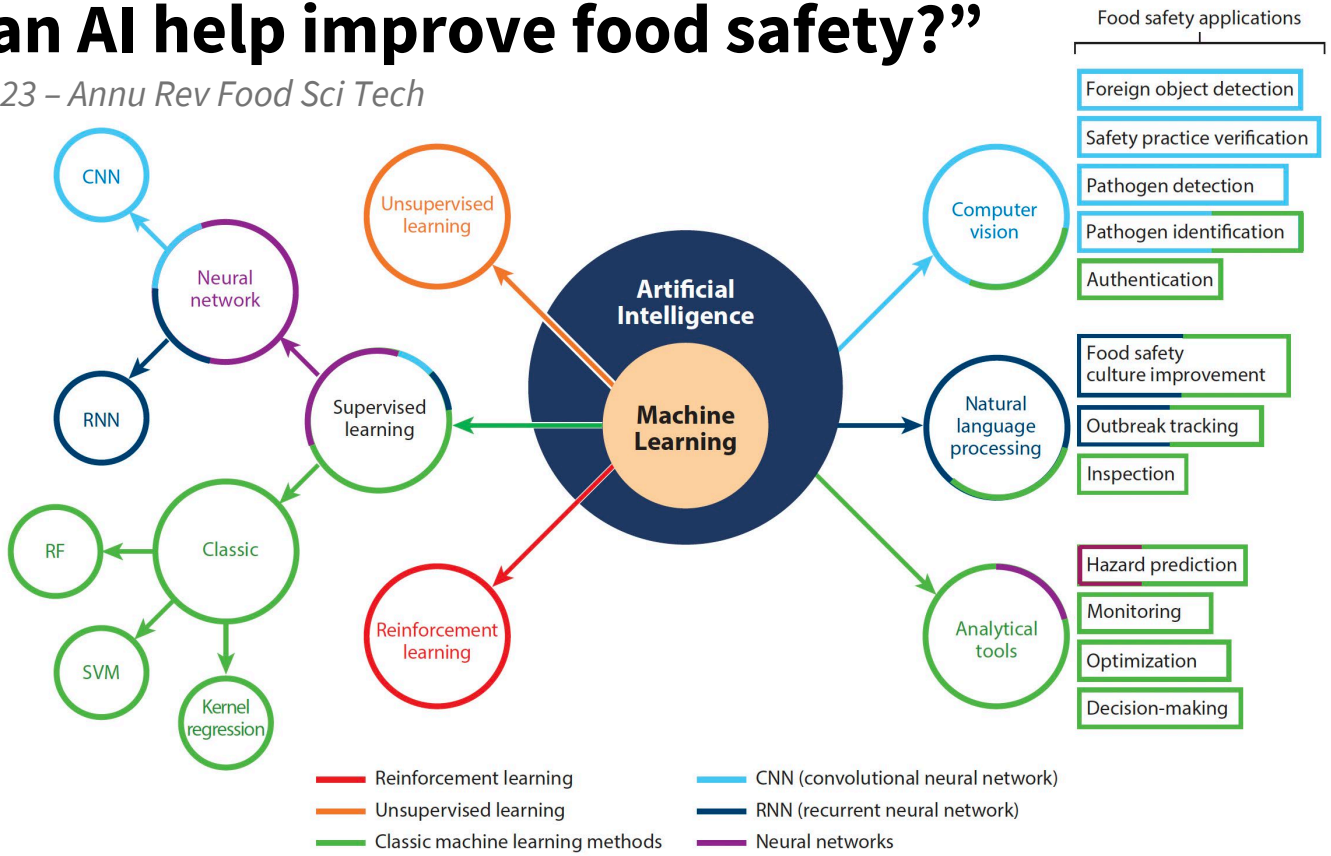
IFT President Peggy Poole says rapid advances in AI and digital tools are transforming food safety, requiring professionals to adapt quickly while leveraging new capabilities to improve decision-making and reduce risk.

Read More

AI in Food Safety

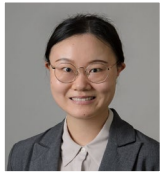
“How can AI help improve food safety?”

Qian et al. 2023 – Annu Rev Food Sci Tech

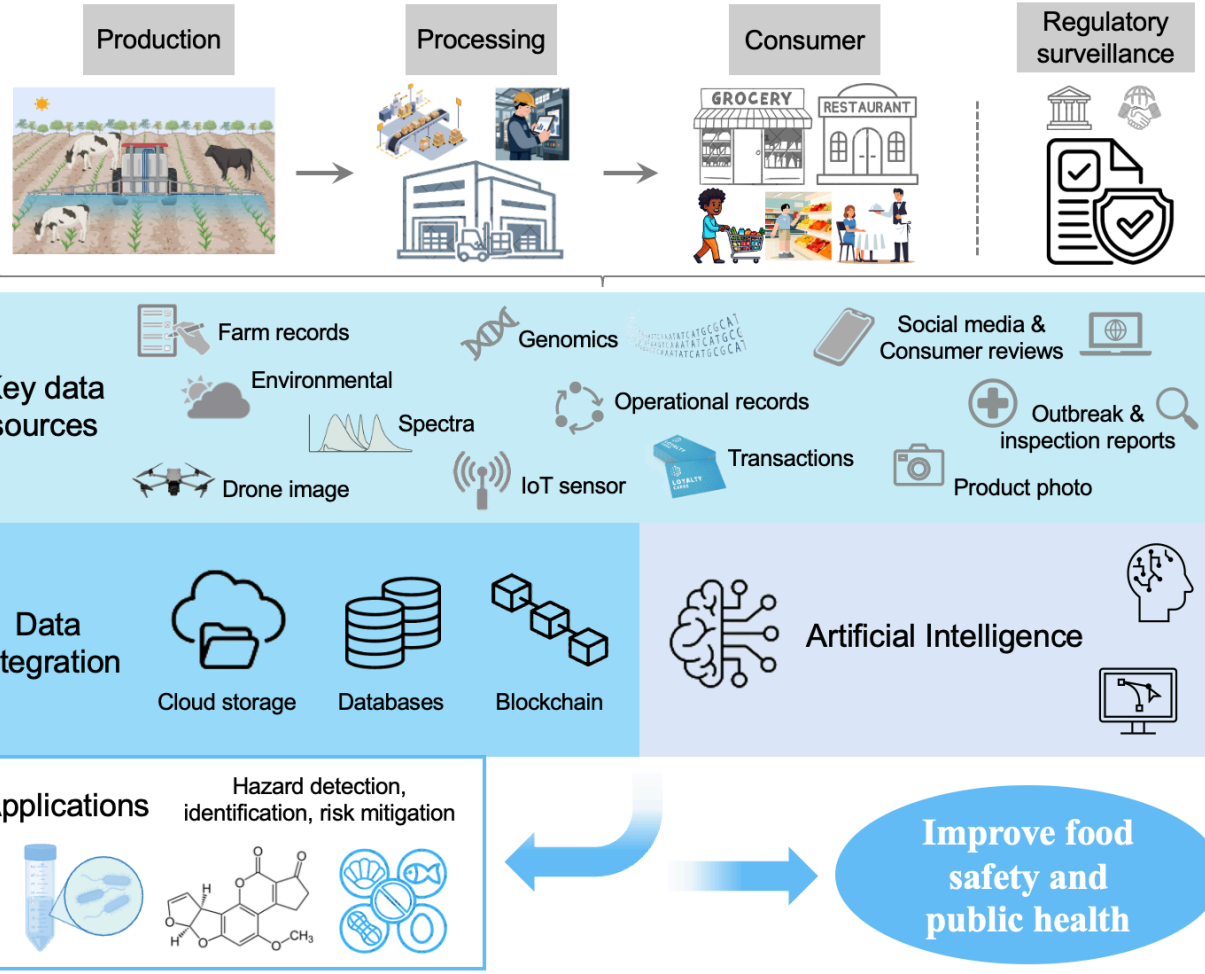


Big Data and AI in Food Safety: Progress and Opportunities

Gao & Blaustein, In Review



Mairui Gao



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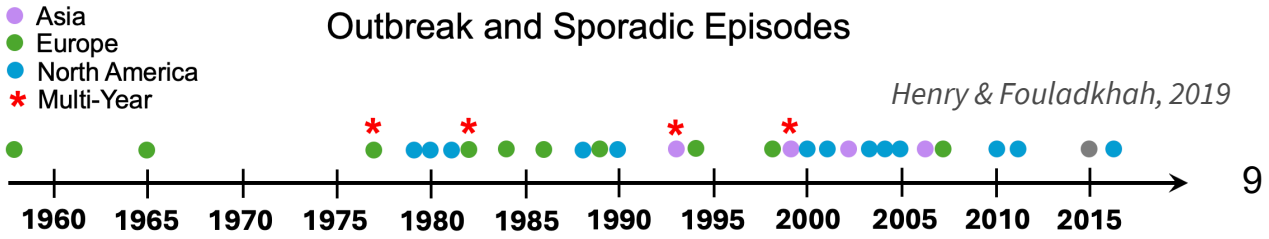
Cronobacter sazakakii across global food system



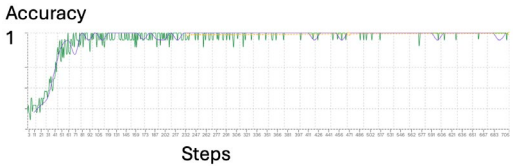
Genomic diversity from production to consumer

NIH National Library of Medicine
National Center for Biotechnology Information

Pathogen Detection BETA

- Genome Accessions
- Location
- Sources

GPT 3.5 fine tune model



Download genome assembly

CheckM

Annotation: Prokka

Pangenome: Panaroo

Key Features
- BLASTp

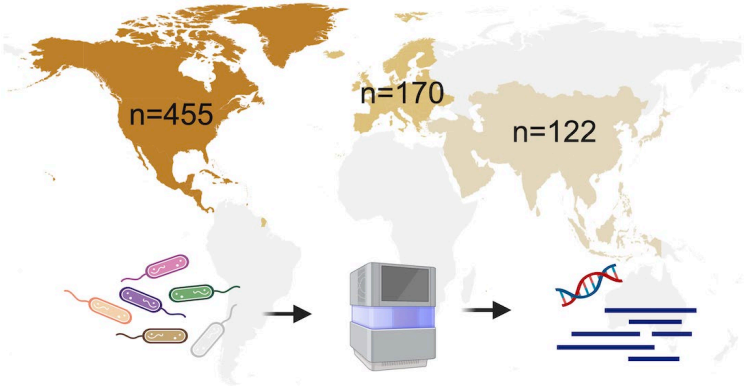
AMR (CARD)
Virulence (VFDB)
- eggNOG-mapper

Metabolism (COG)

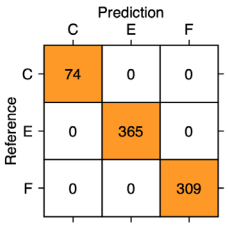
Link to 'Biogeography'

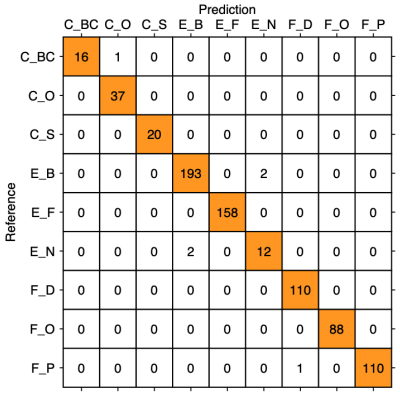
Random Forest

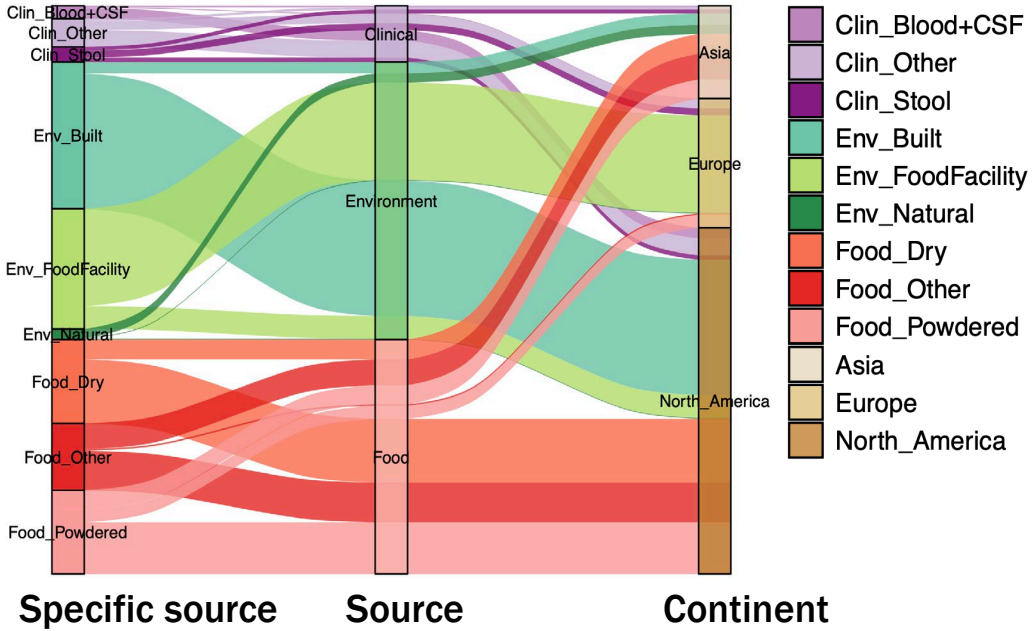
Datasets leveraged, QC metadata and genomic data



Automated metadata categorization

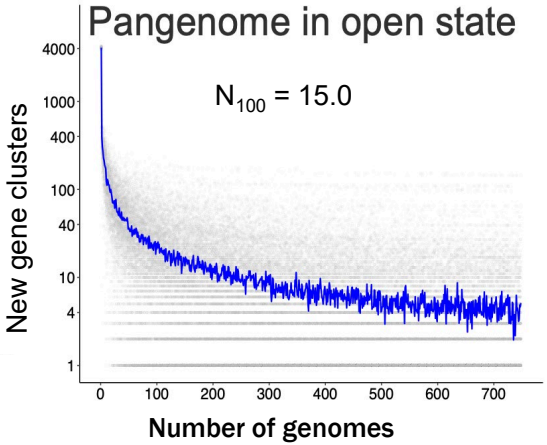


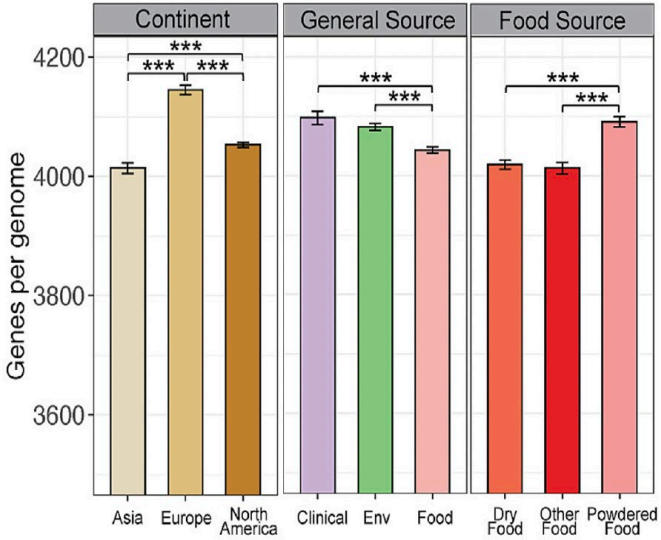


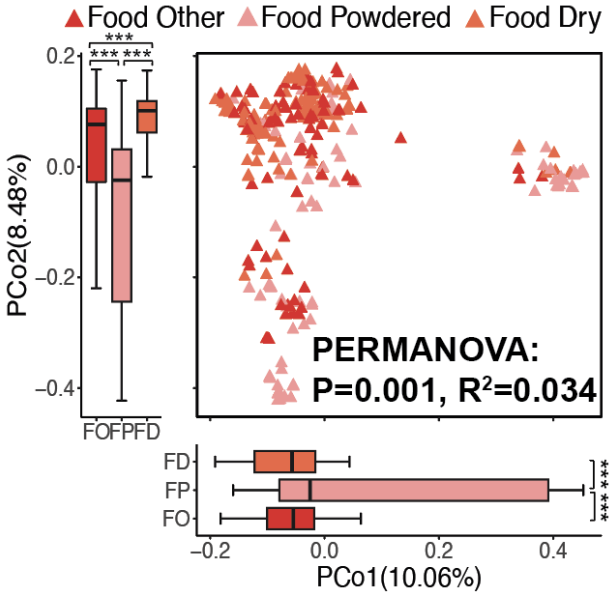


Gao et al. 2025 — Int J Food Micro

Genome content across sources and scale







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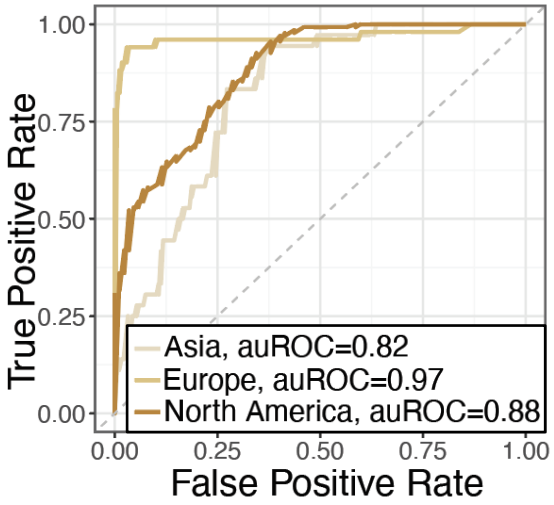
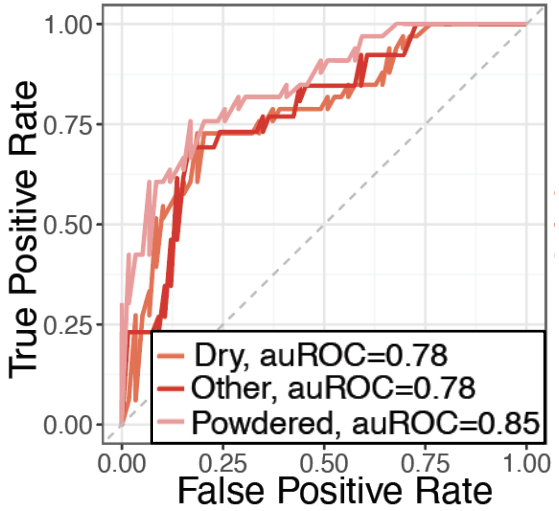
Gao et al. 2025 — Int J Food Micro

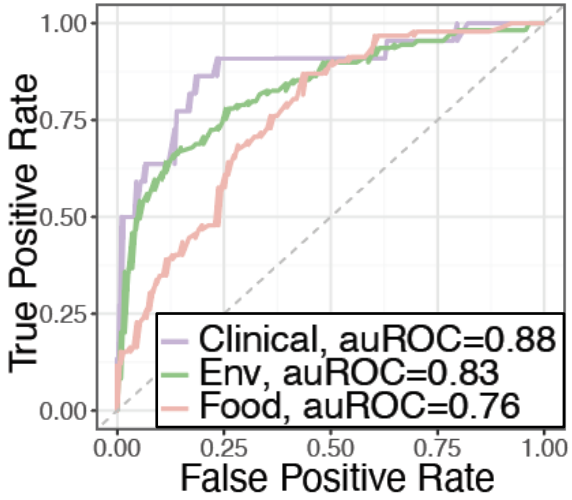
Machine learning accurately predicts isolate origins

Random forest model:

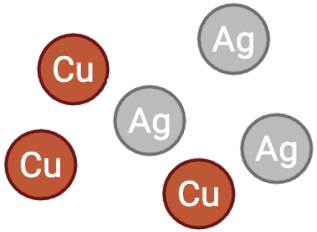
- 70% training set, 30% testing set, 10-fold cross-validation, 10 times repeat



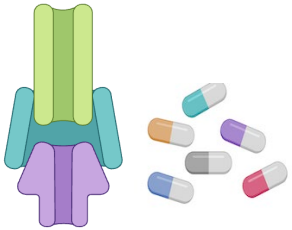




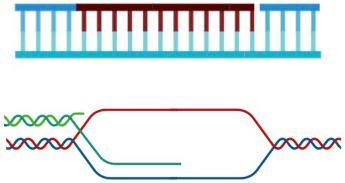
Biogeography of genomic features, including virulence



Heavy metal response

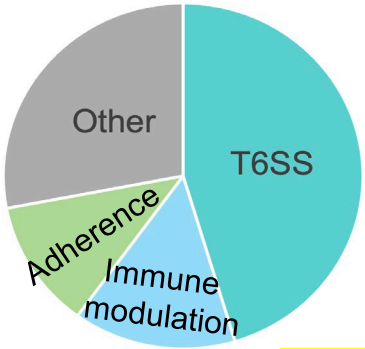


Efflux system

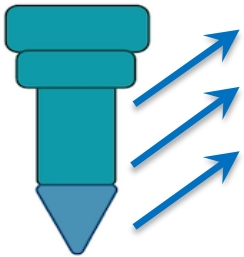


Recombination, replication/repair

Top 50 VF homologs



T6SS

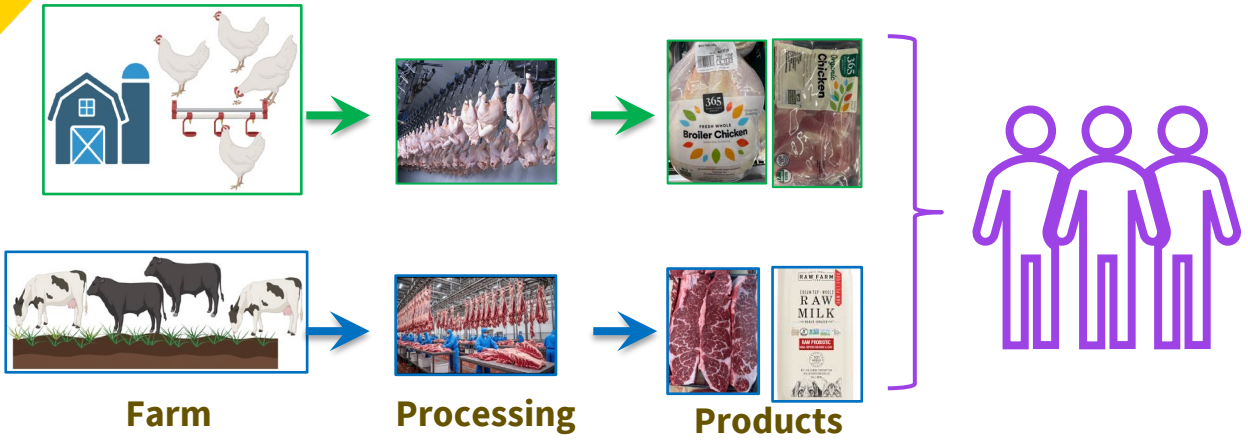


Tube protein: Hcp
Tip protein: VgrG
Outer membrane protein: OmpA

→ ***Molecular targets for risk prediction***

Campylobacter jejuni

Clinical cases reflect evolutionary trajectories from distinct animal reservoirs



Adaptive response to animal origins

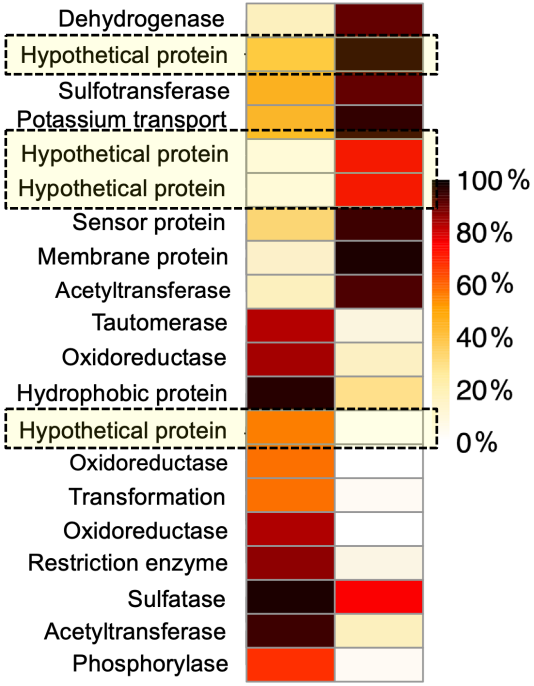
1330 3524 5256

Pangenome

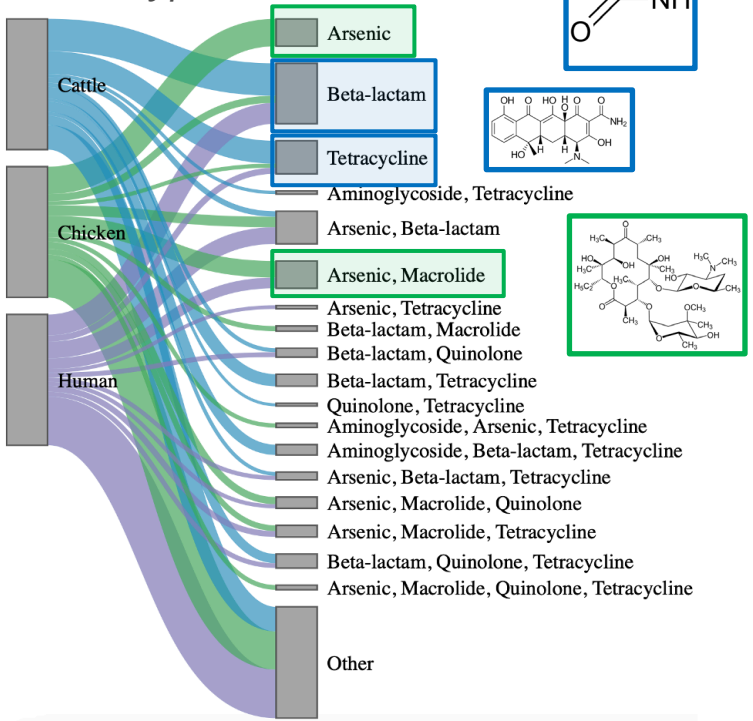
Pangenome characteristics

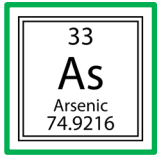
Machine learning

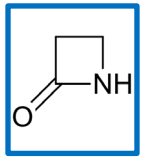
Source-specific markers



AMR Genotype Patterns







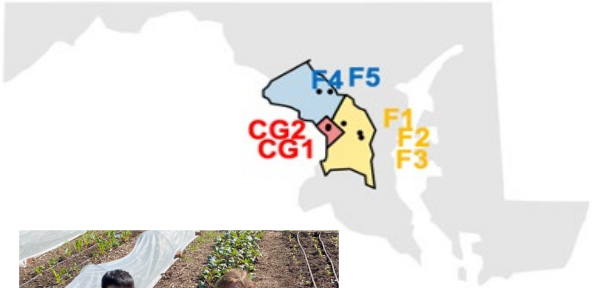
Gao et al. In Preparation

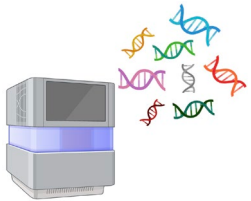
Food and foodborne pathogen traceability

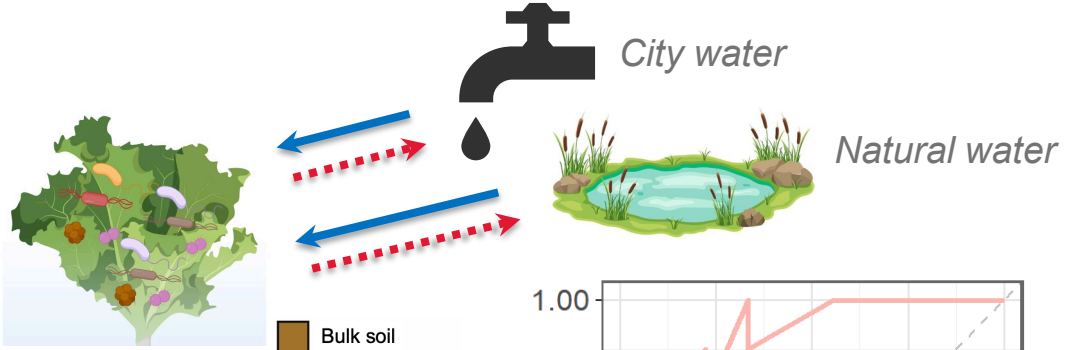
Microbiome and Antimicrobial Resistance (AMR)

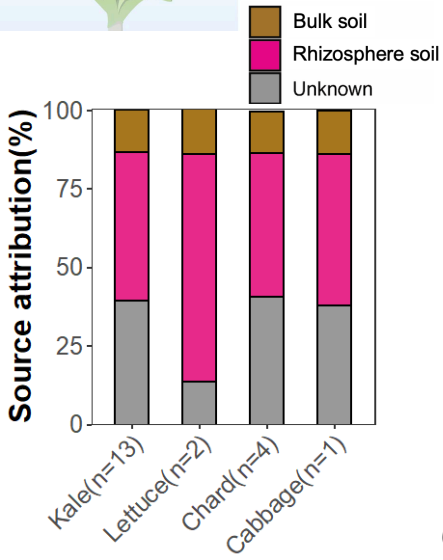
ML predicts irrigation sources from microbiome

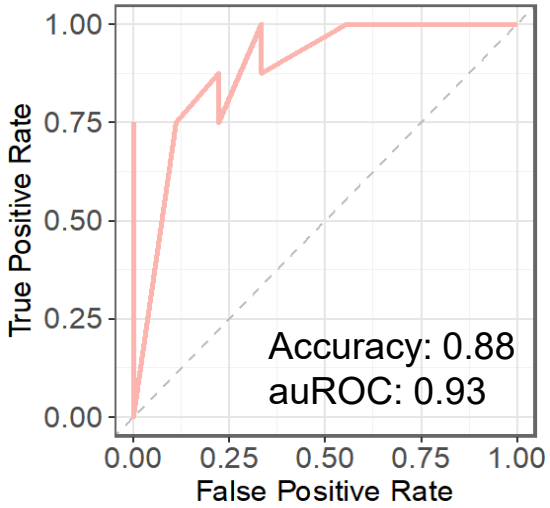
F: Urban farm
CG: Community garden











Gao et al. In Review

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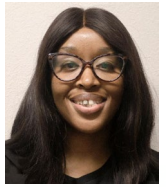
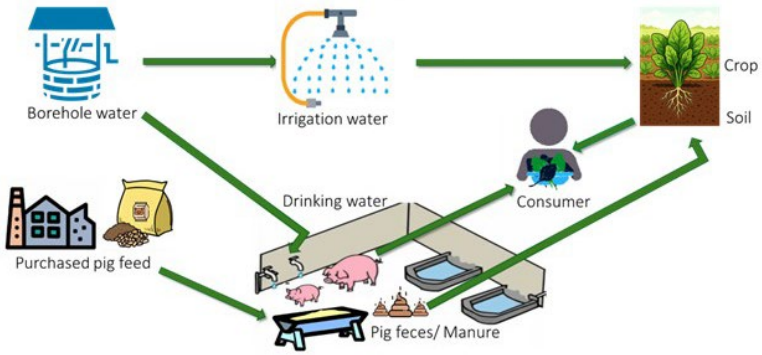
Integrated Farming: AMR *E. coli*



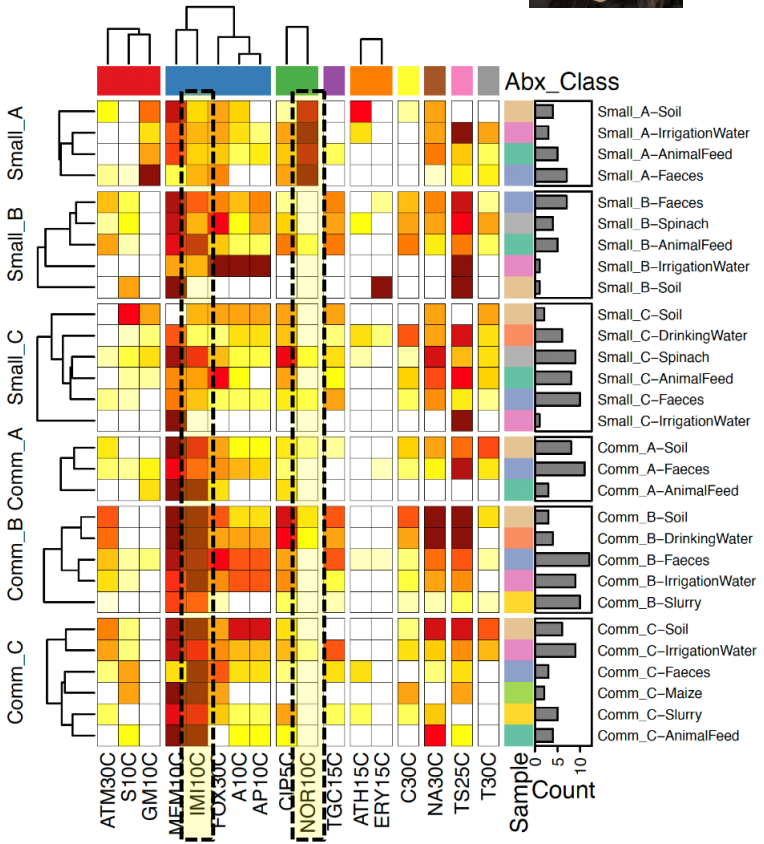
Manana Dlangalala

Small-scale vs. Commercial

Crop & Pig Production



Dlangalala et al. In Review



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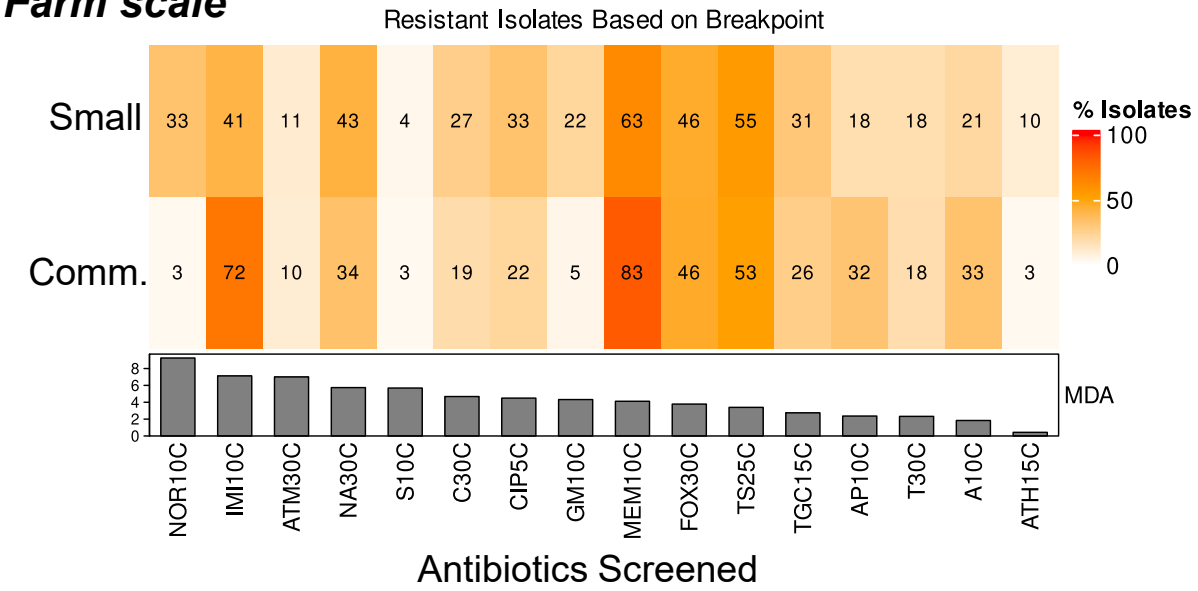
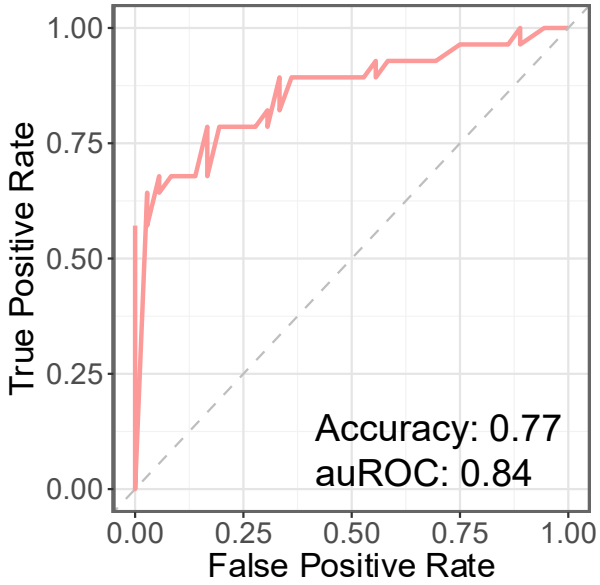
ML predicts *E. coli* source origins

Erin Harrelson

Farm scale





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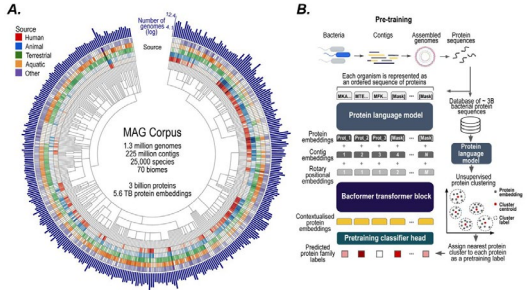
Dlangalala et al. In Preparation

Broader AI applications in food safety

Genomics/Protein language model (gLM/pLM)

Large language model (LLM) on (meta)genomic sequence data

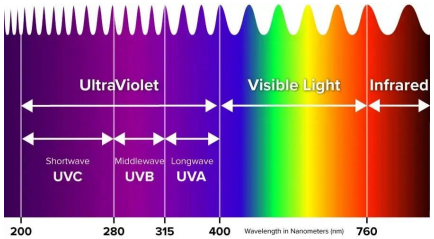
- ESM2 (Lin et al. 2023)
- LookingGlass (Hoarfrost et al. 2022)
- **Bacformer** (Wiatrak et al. 2025)



Imaging/Spectral Systems

Rapid detection applications

- Microscopy
- Raman spectroscopy
- Hyperspectral
- **UV-Vis**
- Integration tools, e.g., YOLOv4, ResNet50, CNNs, transformers)



Hazard extraction

Online resources

- Scientific literature and web-based search
- Transaction and trade records
- Social media content (e.g., TWEET-FID)
- Domain-specific LLMs (e.g., **FoodSky**, FoodGPT)

Zhou et al. 2025

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What AI tools are you and your organizations using?

ChatGPT

Gemini

Copilot

perplexity

What is your preferred AI agent?

Future is still wide open…

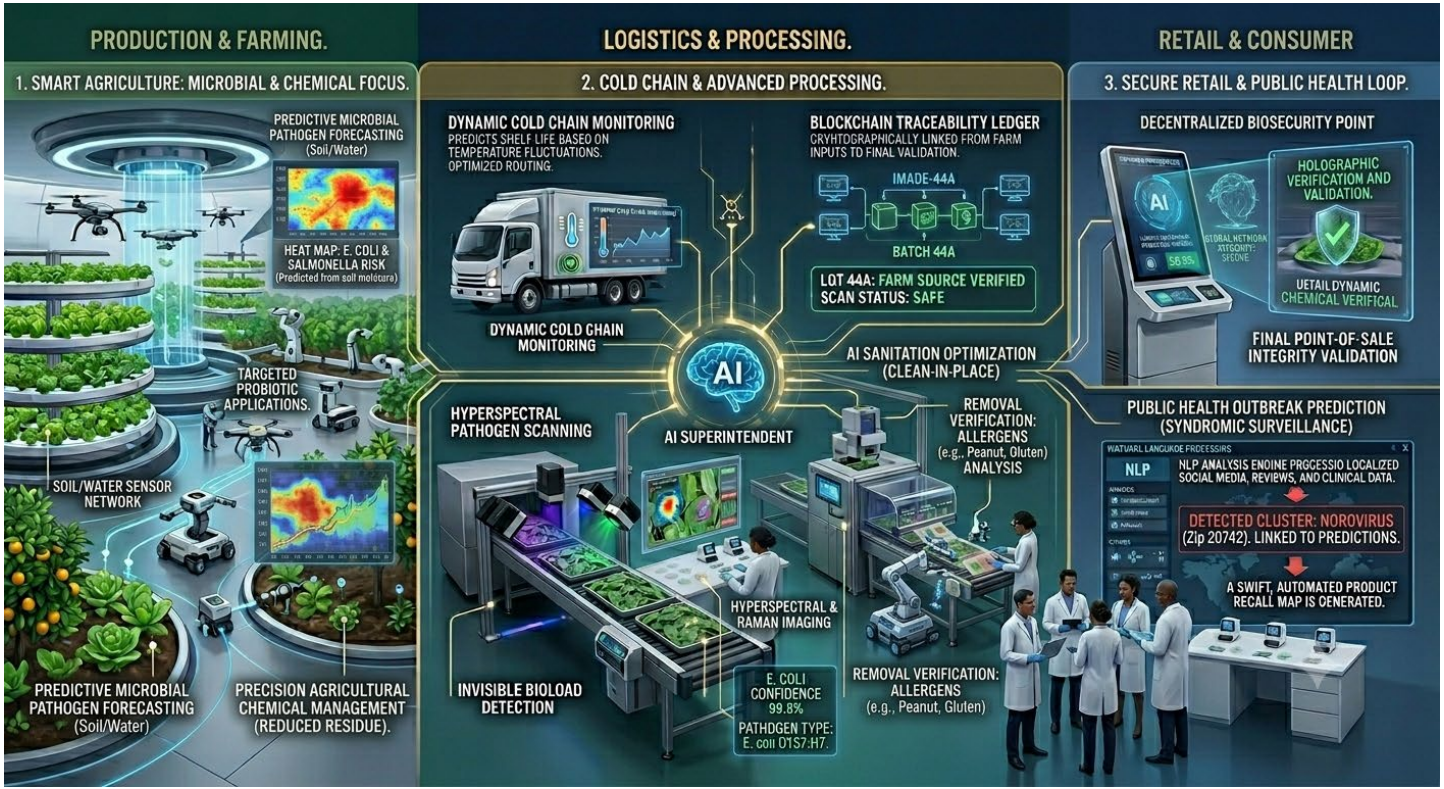

*Image created in Gemini

Summary

- Big data: operational, regulatory, consumer domains
- AI/ML applications are rapidly expanding
- Molecular targets may enhance risk prediction
- Foodborne pathogen genomics
  - Understanding adaptive response
  - Source attributions
- Food traceability

Thank you!

Lab Website

Mairui Gao, PhD
Abani Pradhan, PhD
Mostafa Ghanem, PhD
Magaly Toro, PhD
Shirley Micallef, PhD
Rohan Tikekar, PhD
Manana Dlangalala
Lise Korsten, PhD
Erin Harrelson
Qingyue Zeng
James Jeffrey
Julia Chen
Kevin Lam

rblauste@umd.edu

@rblauste


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Questions?