University of Manitoba | Faculty of Science

Department of Microbiology

# Available Undergrad Research Award (URA) supervisors

**Microbiomes and Microbial Ecology**

**Name**: Matthew Bakker

**Contact information:** Matthew.Bakker@umanitoba.ca

**Website:** https://matt-bakker.github.io/index.html

**Description of research:** Research in the Bakker lab is centered on the fungal plant pathogen Fusarium graminearum. Our aim is a more effective control of fusarium head blight, a disease that impacts wheat, barley and oat crops. We find ecologically-motivated questions to be particularly fun. Some current projects include studies of phosphatases (how does Fusarium get the phosphorus it needs?) and ferulic acid esterase (how does the degradation of plant cell walls during pathogen attack feedback to impact pathogen success?), studies of hydrophobin proteins produced by Fusarium (how does Fusarium activity during malting impact beer quality?), and studies of how other microbes interact with a toxic metabolite that is produced by Fusarium.

**Environmental Microbiology and Ecology, Systems Microbiology**

**Name:** Sean Booth

**Contact information:** Sean.Booth@umanitoba.ca

**Website:** https://boothsci.wordpress.com/

**Description of research:** My research is focused on antagonistic interactions between bacteria. Bacteria use a range molecular system to kill and inhibit competitors – weapons – such as small-molecule antibiotics, protein bacteriocins, and secretion systems to inject cytotoxic proteins directly into competitor's cells. To understand the evolution, ecology, and physiology of bacterial weapons, we ask questions like: why do bacteria make and carry so many different weapons? What determines their effectiveness? How is weapon use connected to metabolism and motility? These questions are approached with a mix of mathematical modelling, computational bioinformatics, synthetic biology, and experimentation where armed bacteria are pitted against each other to see who wins.

**Host-Microbe Interactions**

**Name:** A. Karen Brassinga

**Contact information:** Ann.Brassinga@umanitoba.ca

**Website:** http://jodavies919.wixsite.com/brassingalab

**Description of research:** Our research focuses on understanding the mechanisms used by bacteria to adapt and survive in diverse environments. Our particular focus is on the water-borne bacterium Legionella pneumophila; a parasite of freshwater protozoa featuring a unique intracellular biphasic lifecycle that alternates between replicative forms and cyst forms. Normally intended for prolonged survival between protozoan hosts, cyst forms can also cause a pneumonia termed Legionnaires' disease in susceptible humans. To carry out our investigations, we use diverse range of molecular and microscopic techniques to identify genetic components essential for survival of L. pneumophila in water and in the host cell.

**Genomic Approaches to Antibiotic Discovery and Plastic Degradation**

**Name**: Silvia Cardona

**Contact information:** Silvia.Cardona@umanitoba.ca

**Website:** www.cardonalab.org

**Description of research:** Our research long-term goal is to understand the molecular mechanisms that control microbial growth in diverse environments, such as in infection sites and biotechnological processes. To that end, our lab builds genomic and synthetic biology tools with a focus on essential genes. We apply these tools to the discovery of antimicrobials and the synthesis and degradation of bioplastics. We develop some of these applications in Burkholderia, a group of Gram-negative bacteria that have extraordinary biotechnological potential but also cause opportunistic infections.

**Mitochondrial Membrane Proteins**

**Name:** Deborah Court

**Contact information:** Deborah.Court@umanitoba.ca

**Website:** https://home.cc.umanitoba.ca/~dcourt/

**Description of research:** Our research focuses on mitochondrial membrane proteins. We are investigating the interactions of the voltage-gated anion-selective channel (VDAC) with

hexokinases in fungal mitochondria, and the structure and organization of VDAC in membrane-mimetics such as detergents. We are also investigating the potential role of mitochondrial transporters in protecting mitochondrial translation from the effects of certain antibiotics. We use a range of methods including biophysical analysis of purified membrane proteins, expression of mitochondrial proteins in E. coli, and genetic and cell biology approaches in yeast and Neurospora.

**Fungal Evolution and Genomics**

**Name:** Aleeza Gerstein

**Contact information:** Aleeza.Gerstein@umanitoba.ca

**Website:** http://microstatslab.ca

**Description of research:** Research in the MicroStats lab applies evolutionary principles to broadly understand the factors that influence how and why fungal populations to evolve, particularly in the context of antimicrobial resistance and recurrent infection from human fungal pathogens. We work with different species of human fungal pathogens as well as the eukaryotic genetic model organism Saccharomyces cerevisiae. We collaborate with clinical microbiologists and clinicians in Winnipeg to characterize local isolates to identify when and why different relatedness patterns are observed in different infection contexts and among different species. Our studies typically combine elements of empirical lab work (isolate characterization, drug response phenotyping, experimental evolution) with bioinformatics (analysis of whole genome sequencing data) and statistical analysis (powered by the R Programming Language – no prior experience necessary!).

**Microbial Evolution and Genomics**

**Name:** Georg Hausner

**Contact information:** Georg.Hausner@umanitoba.ca

**Website:** http://geohaus.wixsite.com/curriculum-vitae-r

**Description of research:** Our research characterizes fungal mitochondrial genomes. Fungi are important organisms that have large mitochondrial genomes (compared to metazoans). We study the molecular evolution of mitochondrial mobile introns within the fungi: The focus is on the characterization of mitochondrial genomes of plant pathogens, with an emphasis on the molecular evolution and biology of group-I and group-II introns (ribozymes). This includes the characterization of intron encoded proteins such as homing endonucleases (HEases). HEases are DNA cutting enzymes that have applications in biotechnology. In addition we work on aspects of

fungal taxonomy using various molecular tools and we collect fungi from the environment as potential sources for novel enzymes and antimicrobial compounds (the latter is in collaboration with Dr. Kumar's research group).

**Antimicrobial Resistance**

**Name:** Ayush Kumar

**Contact information:** Ayush.Kumar@umanitoba.ca

**Website:** www.ayushkumarlab.com

**Description of research:** We study the mechanisms of multidrug resistance in Gram-negative pathogens Acinetobacter baumannii and Pseudomonas aeruginosa. Both these organisms are classified as 'critical' by the World Health Organization due to their resistance to almost all classes of antibiotics. Specifically, we are studying multidrug efflux pumps in A. baumannii and P. aeruginosa that belong to the Resistance-Nodulation-Division (RND) family. We are interested in establishing RND pumps' substrate profiles, deciphering their regulatory pathways, understanding their biochemical mechanisms, and investigating their role in the antibiotic resistance as well as virulence of bacteria.

Further, we are also studying the prevalence of bacteria and antibiotic resistance genes in drinking water samples from First Nation communities in Manitoba.

**Molecular Biology of Viral and Bacterial Virulence Mechanisms**

**Name:** Brian Mark

**Contact information:** Brian.Mark@umanitoba.ca

**Website:** http://home.cc.umanitoba.ca/~bmark/Welcome.html

**Description of research:** The Mark laboratory explores the molecular mechanisms that bacteria use to defend themselves from antibiotics, and how viruses evade host immune responses by corrupting the cellular ubiquitin system. Findings from his group are revealing weaknesses in bacteria and viruses that can be exploited as new therapeutic targets to treat infectious disease. For more information please visit the Mark Lab website at: http://home.cc.umanitoba.ca/~bmark/Welcome.html

**Environmental Microbiology and Ecology, Computational Microbiology**

**Name:** Marike Palmer

**Contact information:** Marike.Palmer@umanitoba.ca

**Website: TBA**

**Description of research:** The underexplored natural diversity of microbes is estimated to far surpass the known biodiversity, with environmental genomics efforts showing that immense novelty still remains to be discovered across all of Earth's biomes. This is particularly evident in extreme environments, where many novel microbes and their genes provide insights into evolution, their roles in biogeochemical cycles, and afford opportunities for bioprospecting. My research exploits this novelty through meta-omics approaches to investigate speciation, establish stable taxonomies for uncultivated microbes, and interrogate novel gene architectures for biotechnological potential.

**Pelka Lab**

**Name:** Peter Pelka

**Contact information:** Peter.Pelka@umanitoba.ca

**Description of research:** The Pelka lab studies virus-host interaction with the purpose to better understand how viruses disarm our immune systems in order to replicate efficiently. The Lab is also interested in how viruses cause cancer, therefore we identify how viruses disrupt growth-regulatory pathways in cells that can contribute to cancer development in humans.

**Bacterial Communication and Protein Secretion**

**Name:** Gerd Prehna

**Contact information:** Gerd.Prehna@umanitoba.ca

**Website:** https://home.cc.umanitoba.ca/~prehnag/

**Description of research:** We study how bacteria communicate with their hosts, how they communicate with each other, and how they communicate with other micro-organisms. Currently, our lab studies the molecular mechanisms of protein secretion and inter-bacterial communication in pathogenic bacteria such as Salmonella (food poisoning, typhoid fever) and Streptococcus (strep. Throat, flesh eating disease). We use a diverse range of biochemical and biophysical techniques, including X-ray crystallography and NMR spectroscopy, to determine the function of the bacterial proteins that form secretion systems, serve as toxins, and operate as receptors for signaling events.

**Oresnik Lab**

**Name:** Ivan Oresnik

**Contact information:** Ivan.Oresnik@umanitoba.ca

**Description of research:** Work on the labs interest is in plant-microbe interaction. Specifically symbiotic nitrogen fixation that occurs in legume nodules. The lab uses a variety of genetic, genomic, physiological, and computational approaches to determine the role of carbon metabolism in the rhizosphere as well as within the nodule.

**Microbial Physiology and Ecology for the Bioeconomy**

**Name:** Richard Sparling

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**Website:** https://home.cc.umanitoba.ca/~sparling/R%20Sparling%20website/Home.html

**Description of research:**

1. Understanding the molecular physiology of bioethanol production in the lignocellulolytic waste degrading Clostridium thermocellum, alone and in designed small consortia.
2. Green-House effect mitigation from landfills through the conversion of fugitive methane emissions to CO2 and the potential generation of bioproducts from thermophilic methanotrophic bacteria.

**Microbiomes and Resistome from Aquatic Environments**

**Name:** Miguel Uyaguari

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**Description of research:**

Our overall research encompasses four foci, which are summarized in the following lines:

- Understanding the diversity of environmental microbiomes in different impacted aquatic and terrestrial ecosystems (agriculture, urban or mixed influenced, and protected) by using next- generation sequencing tools to characterize, analyze and compare microbial fingerprints.
- Determining novel indicators for water quality and microbial source tracking using function and sequence-based metagenomics.

- Using state-of-the-art tools to characterize significant changes in microbial community as direct discharges from wastewater treatment plants or concentrated animal feeding operations that may result in the contamination of coastal and freshwater ecosystems.
- Exploring antibiotic resistance genes and the resistome in aquatic ecosystems under high and low levels of anthropogenic influence using metagenomics and their correlation with micropollutants (antibiotics and heavy metals) in the environment.

**Molecular Basis of Protein Synthesis and Antibiotic Action**

**Name:** Hans-Joachim Wieden

**Contact information:** hans-joachim.wieden@umanitoba.ca

**Website:** TBA

**Description of research:** With the steady emergence and spread of antibiotic resistant pathogens, the development of new antibiotics is increasingly important. We study the molecular mechanisms of antibiotic function using a multidisciplinary approach based on synthetic biology and advanced biophysical methods to provide a framework for the development of novel antimicrobial strategies.

Our research focuses on antibiotics that target the cellular machinery of the pathogen responsible for translating genetic information into functional proteins, a process called translation. Translation is carried out by the ribosome, a large (MDa) ribonucleoprotein complex serving as a molecular assembly line. The detailed molecular-level understanding of the involved processes is of fundamental importance for the development of new types of antibiotics. To this end, we study the molecular requirements for the inhibition of translation and analyze how resistance mechanisms work. Ongoing research in our group contributes to the development of novel tests, enabling us to search for chemical compounds that effectively inhibit translation with the potential to become new antibiotics.

Other research-focused faculty members may be available; please see the Department of Microbiology website for further information.