



University  
of Manitoba



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## Available Undergrad Research Award (URA) Supervisors (Alphabetical by Sub-Discipline, Researcher Surname)

### ANALYTICAL CHEMISTRY

**Name:** Sabine Kuss

**Contact Information:** [sabine.kuss@umanitoba.ca](mailto:sabine.kuss@umanitoba.ca)

**Website:** [www.bioanalyticschemistry.com](http://www.bioanalyticschemistry.com)

**Description of Research:** Our research focuses on electrochemistry and its application to biological systems in the fields of endocrinological diseases, antibiotic drug resistance, mitochondrial dysfunctions and cancer development. The high sensitivity of electrochemical methods, such as scanning electrochemical microscopy, allows us to quantify the interaction of specific redox active molecules with single biological cells. Targets of investigation in our group are the detection of diseases, quantification of cell membrane receptor activity and position, monitoring the correlation of membrane pumps with feature activity, and the development of electrochemical biosensors.

**Name:** Gregg Tomy

**Contact Information:** [Gregg.tomy@umanitoba.ca](mailto:Gregg.tomy@umanitoba.ca)

**Website:** [www.cograd.ca](http://www.cograd.ca)

**Description of Research:** The Centre for Oil and Gas Research and Development is a state-of-the-art facility equipped with modern analytical instrumentation committed to advancing and supporting industry and/or government mandated environmental monitoring obligations through the development of faster and cheaper analytical monitoring techniques, tools to delineate sources of crude oil exposures and forensic studies leading to new areas of analytical research.

## BIOCHEMISTRY

**Name:** Ned Budisa

**Contact Information:** nediljko.budisa@umanitoba.ca

**Website:** www.chemsynbio.com

**Description of Research:** Our mission is to preform engineering and control of cellular processes in a chemical way, through synthetic chemistry, genetic code engineering and the directed evolution of enzymes and cells. Synthetic chemistry focuses on various organic syntheses, mainly bioorthogonal amino acids, and examines their effects on model peptides, proteins, protein-based complex scaffolds, and whole cells (populations). Many useful applications including the creation of non-invasive tools for academic and medical research, cells for soil and water remediation, 'bio-batteries' as renewable energy sources or scaffolds for complement electronic and computational devices etc. are envisioned. Students joining the group can expect to gain expertise in most advanced methods of synthetic biology, biological and bioorganic chemistry.

**Name:** Mazdak Khajehpour

**Contact Information:** Mazdak.Khajehpour@umanitoba.ca

**Website:** <http://www.sci.umanitoba.ca/chemistry/profiles/mazdakkhajehpour>

**Description of Research:** Our research focuses on understanding interactions that cause proteins to fold correctly. Most proteins function in a soup of co-solvents that stabilize the protein fold and influence their dynamics. It is the role of that these co-solvents play in the kinetics and thermodynamics of folding that is the focus of our studies. The tools we use include: steady-state and time-resolved fluorescence spectroscopy, stopped flow methods, temperature jump spectroscopy and differential scanning calorimetry.

**Name:** Sean McKenna

**Contact Information:** sean.mckenna@umanitoba.ca

**Website:** <https://home.cc.umanitoba.ca/~mckenna/>

**Description of Research:** Originally thought to be only an intermediary between DNA and proteins, RNA has now emerged as key regulatory molecule in diverse cellular processes. Not surprisingly, aberrant RNA-protein interactions play a key role in a number of disease states. We provide an understanding of the structural features required for RNA recognition by cellular proteins, and correlate this information with biological function in the context of both oncogenic transformation (cancer) and the response of the immune system to viral infection. Students joining the group can expect to gain expertise in structural biology, biochemistry, and molecular/cellular biology approaches.

## BIOCHEMISTRY CONTINUED

**Name:** Joe O'Neil

**Contact Information:** joe.oneil@umanitoba.ca

**Website:** <http://home.cc.umanitoba.ca/~joneil/#Research>

**Description of Research:** Our research focuses on understanding protein biological activity through studies of protein dynamics. Proteins under investigation include the transactivator of transcription from the Human Immunodeficiency Virus-1 (HIV-1), the bacterial glycerol facilitator integral membrane channel and a viral deubiquitinase enzyme. Tools we use include a variety of molecular cloning techniques, computer simulations of protein molecular dynamics, NMR spectroscopy, circular dichroism spectropolarimetry, and hydrogen-deuterium exchange measurements.

**Name:** Helene Perreault

**Contact Information:** Helene.Perreault@umanitoba.ca

**Website:** [home.cc.umanitoba.ca/~perreau](http://home.cc.umanitoba.ca/~perreau)

**Description of Research:** This summer research project will consist of developing a quantitative method to determine the abundance of subclasses of antibodies in porcine serum samples. The research assistant will synthesize small peptides which correspond to amino acid segments unique to each subclass (e.g. IgG1, IgG2) and use these for quantitation. This project is part of a collaboration with the Université de Nantes (France) on xenotransplantation, i.e. the possibility of using animal-to-human grafts in cases where no compatible donor is available. Antibodies are at the heart of these studies.

## INORGANIC AND MATERIALS CHEMISTRY

**Name:** Mario Bieringer

**Contact Information:** mario.bieringer@umanitoba.ca

**Website:** <https://home.cc.umanitoba.ca/~bieringe/>

**Description of Research:** The Bieringer solid-state inorganic materials chemistry research group focuses on alternative energy related (Solid State Fuel Cells) and magnetic (magnetic sensing and interactions) materials with special emphasis on the formation and the stability of the next generation high-performance materials. Typical research projects start out with materials synthesis in the laboratory and progress to structure determination, reactivity studies and physical property measurements including X-ray and neutron diffraction, spectroscopic experiments, ion conduction and magnetic measurements among others.

## INORGANIC AND MATERIALS CHEMISTRY CONTINUED

**Name:** David Herbert

**Contact Information:** david.herbert@umanitoba.ca

**Website:** <http://home.cc.umanitoba.ca/~dherbert/>

**Description of Research:** Summer projects are available in synthetic chemistry - making molecules, polymers and materials for applications in renewable energy (solar light harvesting), functional materials (emissive compounds, sensors) and chemical catalysis (solar fuels and chemicals from CO<sub>2</sub>). Student researchers in the group learn how to carry out air/moisture sensitive reactions using glove-box and vacuum line techniques, NMR spectroscopy, single-crystal X-Ray diffraction, electrochemistry and a host of other techniques.

**Name:** Scott Kroeker

**Contact Information:** scott.kroeker@umanitoba.ca

**Website:** <https://home.cc.umanitoba.ca/~kroekers/>

**Description of Research:** Materials chemistry involves structural studies of solids designed to perform a particular function based on their unique properties. Research in the Kroeker lab focuses on the investigation of inorganic crystals and glasses using solid-state nuclear magnetic resonance (NMR) spectroscopy and computational methods to understand the molecular-level structural origins of desired materials properties. Projects include materials for nuclear waste disposal, bioactive glasses and structural studies of metal-organic frameworks.

**Name:** Victor Nemykin

**Contact Information:** Victor.Nemykin@umanitoba.ca

**Website:** <https://home.cc.umanitoba.ca/~nemykinv/>

**Description of Research:** Synthesis, characterization, and theoretical modeling of the functional dyes useful in light-harvesting modules in solar cells, molecular electronics (new generation of the random-access modules, molecular wires, molecular diodes), redox-activated imaging (environmental monitoring, bio-imaging in medicine), and green catalysis (solar fuels, hydrogen production, and selective catalysis). Research in the Nemykin lab centers around new functional materials, which have specific optical properties. Available summer projects are focused on making small organic, inorganic, and organometallic molecules, characterization of new functional materials in solution and solid state using spectroscopy, electrochemistry, and spectroelectrochemistry, and modeling of their electronic structures using modern computational methods.

## ORGANIC CHEMISTRY

**Name:** Rebecca Davis

**Contact Information:** Rebecca.Davis@umanitoba.ca

**Website:** <http://home.cc.umanitoba.ca/~davisrl/>

**Description of Research:** The Davis group works to develop new methods for producing enantiopure, bioactive compounds relevant to the pharmaceutical and agrochemical industries. We design molecules to interact with proteins of interest and then develop methods to synthesize our molecules from cheap, abundant compounds (e.g. amino acids and petrochemicals). We accomplish this goal using a combination of advanced synthetic techniques, spectroscopic analysis, mechanistic studies and computational chemistry. As a part of the Davis group students will gain experience working in a fast-paced and exciting research environment.

**Name:** Frank Schweizer

**Contact Information:** schweize@cc.umanitoba.ca

**Website:** [home.cc.umanitoba.ca/~schweize/index.html](http://home.cc.umanitoba.ca/~schweize/index.html)

**Description of Research:** Research in the Schweizer group focuses on the development of novel therapeutic approaches to treat multidrug-resistant bacterial infections and cancer. Students enrolled in an undergraduate research project will be trained in medicinal chemistry with the goal to develop novel antimicrobial/antitumor agents which can overcome current bacterial or cancer cell associated resistance mechanisms or delay resistance development. Besides chemical synthesis of new agents or chemical modifications of existing drugs, students will also probe or test how the newly synthesized agents interfere with growth or killing of bacteria/tumor cells alone or in combination with legacy drugs.

**Name:** John Sorensen

**Contact Information:** John.Sorensen@umanitoba.ca

**Website:** <http://home.cc.umanitoba.ca/~sorensen0/>

**Description of Research:** My research program is interested in novel problems in the area of natural products chemistry with a strong focus on biosynthesis. Our attention is on small bioactive molecules that possess interesting biological activity. In particular we focus on linking the genes (and gene clusters) in the microorganism with the profile of small organic molecules that are produced by these organisms. We have been focusing on the polyphenolic natural products produced by lichen fungi. One of our ongoing interests is to be able to deduce the signals that are involved in triggering natural product biosynthesis in lichen and other fungi.

## PHYSICAL/COMPUTATIONAL CHEMISTRY

**Name:** Kathleen Gough

**Contact Information:** Kathleen.Gough@umanitoba.ca

**Website:** <http://home.cc.umanitoba.ca/~kmgough/index.htm>

**Description of Research:** Critical chemical interactions occur at the nanoscale but impact materials at every dimension. Research in my group is centered on vibrational spectroscopy, more specifically, spectrochemical imaging at micro- and nano-scales. Targets range from Arctic sea ice diatoms (climate change) and blood cells (cancer), to scar in post-infarct cardiac tissue (heart disease) and mechanically damaged collagen fibrils. Techniques include FTIR and Raman spectromicroscopy. Super-resolution experiments that break the infrared diffraction limit are done at the Advanced Light Source, Berkeley CA, allowing us to explore at the previously inaccessible nanoscale.

**Name:** Christian Kuss

**Contact Information:** christian.kuss@umanitoba.ca

**Website:** <https://kussmaterials.com>

**Description of Research:** Rechargeable batteries have made mobile technology possible. Now they are needed again to enable the renewable energy revolution. We work on the development of new battery materials for Li-ion, Na-ion, and all-solid-state battery technology, to improve battery capacity, charging time, safety and cost. Undergraduate students will synthesize materials, perform characterization in our lab or at the Manitoba Institute for Materials, fabricate electrodes and button cells, and test those batteries.

**Name:** Georg Schreckenbach

**Contact Information:** schrecke@cc.umanitoba.ca

**Website:** <http://home.cc.umanitoba.ca/~schrecke/>

**Description of Research:** Computational chemistry: We use computers to model chemistry and materials across the periodic table, often in collaboration with experimental researchers. Current topics include (i) the chemistry of the actinides (Ac, Th, U, Np, Pu and the rest of the 5f series), with applications for instance to radiotherapy, (ii) two-dimensional (2D) materials, (iii) conducting polymers) (iv) quantum-chemical method development, (v) solar energy conversion, among others. A detailed description specifically for undergraduate students is given on my webpages.

## PHYSICAL/COMPUTATIONAL CHEMISTRY CONTINUED

**Name:** Jennifer van Wijngaarden

**Contact Information:** [vanwijng@cc.umanitoba.ca](mailto:vanwijng@cc.umanitoba.ca)

**Website:** <http://home.cc.umanitoba.ca/~vanwijng/index.htm>

**Description of Research:** Reactive intermediates drive reactions but little is known about their properties (structures, barriers) as they are so unstable under typical conditions. In this group, unstable species are generated in ultracold jets (5 K) and studied using state-of-the-art microwave spectrometers. Complementary infrared data is collected at the Canadian Light Source synchrotron each summer with the help of students. Of particular interest are unstable species found in astrochemical environments (stars, clouds).



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### HOST-MICROBE INTERACTIONS

Name: Ann 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. Current targets of investigation in our group are the environmental bacteria *Legionella pneumophila* and *Serratia marcescens*. *L. pneumophila* is a parasite of freshwater protozoa and has 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. *S. marcescens* is also an opportunistic human pathogen known for multidrug resistance gained through modulation of its bacterial physiology and horizontal gene transfer. To carry out our investigations, we use a diverse range of molecular biology approaches.

### 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>

### 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 the understanding of structure and function of the voltage-gated anion-selective channel (VDAC) in fungal mitochondria. We are investigating the structure and organization of VDAC in membrane-mimetics such as detergents, using a variety of biophysical methods. We are also probing the roles of this membrane protein in the function and regulation of mitochondrial and cellular activities, using proteomic and genetic approaches.

## BACTERIAL COMMUNICATION AND PROTEIN SECRETION

**Name:** Gerd Prehna

**Contact Information:** [gerd.prehna@umanitoba.ca](mailto: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.

## ANTIMICROBIAL RESISTANCE

**Name:** Ayush Kumar

**Contact Information:** [Ayush.Kumar@umanitoba.ca](mailto:Ayush.Kumar@umanitoba.ca)

**Website:** [www.ayushkumarlab.com](http://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 APPROACHES TO CONTROL BACTERIAL GROWTH

**Name:** Silvia Cardona

**Contact Information:** [Silvia.Cardona@umanitoba.ca](mailto:Silvia.Cardona@umanitoba.ca)

**Website:** [www.cardonalab.org](http://www.cardonalab.org)

**Description of Research:** The Cardona lab is interested in the molecular mechanisms that regulate bacterial growth with the long-term goal of controlling bacteria in infection conditions or during biotechnological applications. One project involves genomic exploration of essential process in bacteria with the goal of predicting antibiotic activity of novel small molecules and identifying their mechanism of action. A second project is related to the use of CRISPR interference for exploring bacterial metabolic pathways relevant to bioremediation.

## MICROBIAL EVOLUTION & 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).

**Name:** Aleeza Gerstein

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

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

**Description of Research:** In the MicroStats lab we seek to understand the genotypic and phenotypic basis of stress resistance and adaptation in fungal microbes. We work with different species of human fungal pathogens and the eukaryotic genetic model organism *Saccharomyces cerevisiae*. We collaborate with clinical microbiologists and clinicians in Winnipeg to study the fungal isolates that infect Manitobans, with the long-term goal of determining the factors that constrain and promote diversity in the context of drug resistance and human virulence. Our studies typically combine elements of isolate characterization, experimental evolution, whole genome sequencing, and computational and statistical techniques (e.g., genome wide association studies).

## 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 investigates plant-microbe interactions and plant-associated microbiomes, particularly in relation to agricultural productivity and sustainability. Some of our current study systems include the disease fusarium head blight, microbiome dynamics during malting, microbial detoxification of mycotoxins, and soil health & disease suppressive soils.

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



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- Prof. Wouter Deconinck. Email: [Wouter.Deconinck@umanitoba.ca](mailto:Wouter.Deconinck@umanitoba.ca)
- Prof. Michael Gericke. Email: [mgericke@physics.umanitoba.ca](mailto:mgericke@physics.umanitoba.ca)
- Prof. Juliette Mammei. Email: [jmammei@physics.umanitoba.ca](mailto:jmammei@physics.umanitoba.ca)

Profs. Deconinck, Gericke, and Mammei work on various partially overlapping experimental subatomic physics projects in Winnipeg and at facilities in Virginia (USA) and Mainz (Germany). They are currently involved in several precision tests of the Standard Model of particle physics, our current best theory of fundamental particles and their interactions. These large international experiments provide opportunities to gain experience in particle detector technologies, fast read-out electronics, and large data analysis on high performance computer clusters around the world. In addition, Prof. Deconinck is also involved in neutron lifetime measurements at NIST (USA) and various interdisciplinary projects."

- Prof. Stephen Pistorius  
Contact Information: Department of Physics and Astronomy / Biomedical Engineering  
Email: [stephen.pistorius@umanitoba.ca](mailto:stephen.pistorius@umanitoba.ca)  
Room 205 Allen (Physics) Building

Research Description: My research interests focus on image processing and reconstruction, medical device development, improving, optimizing, and quantifying various diagnostic and therapeutic techniques and in modeling and understanding radiation transport for clinically useful imaging and treatment modalities. My current research seeks to develop improved systems for disease diagnosis that uses artificial intelligence for tumour detection and classification, image reconstruction, registration and analysis; scatter enhanced x- and gamma-ray techniques; and the development of medical devices and advanced reconstruction algorithms for microwave-based breast imaging and cancer detection.

Key Words: Medical Image Reconstruction, Scatter Imaging, Microwave Imaging, Machine Learning & AI for medical imaging and breast cancer detection.

- Prof. Can-Ming Hu  
Email: [hu@physics.umanitoba.ca](mailto:hu@physics.umanitoba.ca)  
Website: <http://www.physics.umanitoba.ca/~hu>

Research Description: Developing cavity spintronics devices for microwave and quantum applications

Cavity Spintronics is an emerging field that studies the strong coupling between cavity microwaves and magnetic materials. Via the quantum physics of spin-photon entanglement on the one hand, and classical electrodynamic coupling on the other, this frontier connects some of the most exciting modern physics, such as quantum information and quantum optics, with one of the oldest science on the earth, the magnetism. Students working on this project will start with the intuitive example of coupled harmonic oscillators, gradually learn the concepts of coherent and dissipative coupling, and build simple devices that are useful for microwave and quantum applications.

- Dr Robert Stamps  
Email: [Robert.Stamps@umanitoba.ca](mailto:Robert.Stamps@umanitoba.ca)

Research Description: In Conway's game of life, dots appear and disappear on a computer simulated checkerboard and evolve into interesting, complex patterns.

The rules governing the existence of each dot are engagingly simple, but the resulting behaviour can be incredibly complex. The appearance of complex behaviour in physical systems governed by analogously simple rules is sometimes called 'emergence'. We search for and study many versions of 'emergence' using computer simulations of model physical systems. Our models have inspired several experiments on the real systems these models represent. Examples of physical systems we have modelled are kinetic roughening of magnetic domain walls, motion detection in human visual systems, and most recently, ordering processes in artificial spin ice. This project will explore a phenomena called 'emergent frustration' in an artificial skyrmion crystal using large scale simulations run on a recently commissioned cluster of graphical processing units.

- Prof. Christopher O'Dea  
Email: [odeac@umanitoba.ca](mailto:odeac@umanitoba.ca)
- Research title: Feedback from Supermassive Black Holes to their Host Galaxies  
Research description: Accretion onto supermassive black holes in the centers of galaxies is thought to power activity across the electromagnetic spectrum. The accreting material can produce numerous high energy photons, ionizing gas and driving an outflow of gas from the galactic center. In some cases, relativistic jets are produced which emit radio emission and can propagate to galactic scales. The radiation pressure and kinetic energy of the jets can have a strong effect on the formation and evolution of the host galaxy. I study the effect this feedback has on the environment of the supermassive black holes.