Research in Molecular Biosciences

2017-2018

Research experience during your undergraduate careers is a great way to gain in-depth exposure to your field. Working with a faculty mentor, you can be part of a larger research project that is pushing scientific boundaries. You will gain first-hand experience in how science works (or often doesn't), and what a job in your field could look like after you graduate. This experience is also beneficial if you are planning on continuing on to graduate or professional schools after you earn your degree.

To get involved in research, identify projects that you are interested in and contact the faculty involved. Opportunities vary each semester.

On the following pages, faculty are broadly grouped according to their primary specialties. However, many faculty use techniques and have projects that span many of the groupings. The groupings are as follows.

Biochemistry and Biophysics
Cell and Developmental Biology
Chemical Biology and Medicinal Chemistry
Genetics and Molecular Biology
Microbiology and Immunology
Physiology and Systems Biology

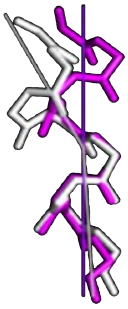
Biochemistry and Biophysics

Biochemists and Biophysicists are interested in how chemical and physical rules affect biological macromolecules. Biological macromolecules such as proteins and nucleic acids adopt specific three-dimensional structures that allow them to perform precise biological functions. As examples, DNA forms a double helix that allows it to store genetic information, proteins adopt compact globular structures in order catalyze chemical reactions, and the structure of RNA molecules can determine how much of a particular protein is manufactured by a cell. All of these structures and functions are dictated by how the macromolecules interact with themselves and their surroundings via their chemical and physical properties.

Adrienne Loh

aloh@uwlax.edu

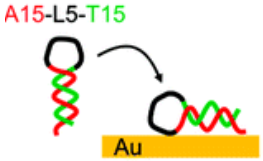
Peptide-based antibiotics offer promise as a robust solution to the antibiotic resistance crisis. My group uses NMR and circular dichroism spectroscopies, isothermal titration calorimetry, and other thermodynamic and computational techniques to study the structures of model antibiotic peptides and their interactions with lipid membranes. Ultimately, we aim to improve peptide antibiotic drugs. Currently, I work with groups at Cornell University in Ithaca, NY and Universite Pierre et Marie Curie in Paris, France. I try to bring students to work with me on location during the summer.



Aric Opdahl

aopdahl@uwlax.edu

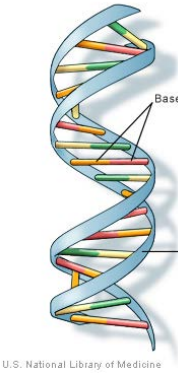
My research program is in the field of *biointerfaces*. We develop analytical methods for studying how biological molecules, such as DNA and protein, behave when they are chemically attached to surfaces. This program crosses from chemistry into the disciplines of biology, physics, and engineering. It is technologically important for the development of advanced medical diagnostics used to understand diseases at a genetic level. Most recently, we have developed unique ways to control the organization of DNA and proteins on surfaces and have developed new instrumentation for quantifying the thermodynamics of these molecules when they are attached to surfaces.



Dan Grilley

dgrilley@uwlax.edu

The goal of my research is to understand in mechanistic detail how the chemical properties of DNA affect its structure and thus its function inside of living cells. Specifically, my research focuses on two related problems: How do the chemical properties of DNA affect its stiffness; and, How does that stiffness affect how DNA is compacted to fit inside a cell. Answers to these questions will help us understand gene regulation. We study these processes using biochemical, biophysical, and molecular biology techniques.



Jennifer Klein

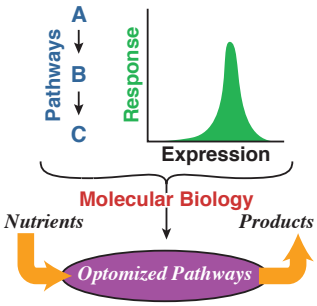
jklein@uwlax.edu

My research program focuses on understanding how molecules sense, respond, and are eventually damaged by oxidative stress. We examine how oxidative protein modifications trigger functional and structural changes in the proteins involved in muscle contraction. Undergraduate projects involve molecular biology to create proteins for site-directed spectroscopy, cell culture and protein expression, carrying out biochemical assays, mass spectrometry and biophysical spectroscopy.

Paul Schweiger

pschweiger@uwlax.edu

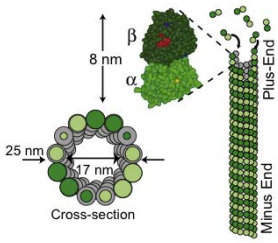
My research combines microbiological, biochemical, synthetic/molecular biology, and systems approaches to engineer microbes for novel and increased production of high value products. We use metabolic and gene expression data to systematically manipulate microbial metabolism by altering gene expression, adding new genes, or deleting genes to produce end-products that have industrial applications. Using microorganisms as catalysts has many advantages over other chemical approaches, such as increased yields, high stereo- and regio-specificity, and use of renewable living catalysts.



Taviare Hawkins

thawkins@uwlax.edu

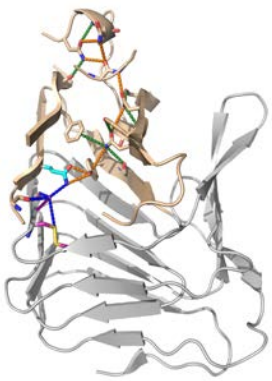
Microtubules are an essential component of the cytoskeleton: providing cell shape, intracellular transport, motility, and generating force when the cell undergoes mitosis. Understanding the underlying mechanical nature of tubules and how those mechanics can be regulated will provide novel and fundamental knowledge about these biological processes. My research **characterizes the mechanics of microtubule filaments: alone and in unison with other cytoskeletal filaments.** I work with an interdisciplinary team of scientists (here and elsewhere) from physics, biology, chemistry, and engineering to perform biochemical assays, fluorescence microscopy, image processing and analysis.



Todd Weaver

tweaver@uwlax.edu

Research in my laboratory is focused on protein folding as related to beta-helix proteins. Beta-helix proteins have been implicated in both infectious and non-infectious protein disorders, like food-borne illness and Parkinson's. Most recently, we have been able to identify two thermodynamically independent folding domains, termed the amino-cap and helix core. The amino-cap is highly stable and appears to be utilized during the alignment of parallel beta-strands during energy independent beta-helix formation. The broader impact of the research extends from gram-negative bacterial virulence to beta-amyloid disease.



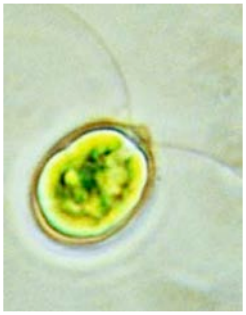
Cellular and Developmental Biology

Cellular and Developmental Biologists study the organization and regulation of cells and organisms. They are broadly interested in how cells grow and develop into complex organisms. They are also interested in how specific cell types are produced and maintained.

Anton Sanderfoot

asanderfoot@uwlax.edu

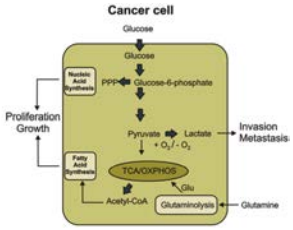
My lab uses genetic, cell and molecular biological techniques to investigate the protein machinery involved in driving the **secretory pathway of green plants**. We use the flowering plant ***Arabidopsis***, as well as the unicellular plant ***Chlamydomonas*** as model systems for identifying novel machinery and test beds for potential applications for crop plants. The lab also has an interest in the evolution and annotation of the protein machinery involved in vesicle trafficking, with a special interest in the novelty of the plant lineage as well as the conservation across all eukaryotes.



Sunny Guin

sguin@gundersenhealth.org

Abnormal metabolism in cancer cells is responsible for aggressive cancer cell growth and metastasis. We recently determined that the essential glycogen debranching enzyme, which is involved in glycogen breakdown, regulates cancer cell proliferation. A major focus of my lab is investigating the cellular processes controlled by glycogen debranching enzyme in cancer cells. Our goal is to understand the processes which drive aggressive tumor growth and apply these studies to the development of new treatment strategies for a wide range of cancer patients.



Jennifer Miskowski

jmiskowski@uwlax.edu

My research program focuses on the molecular basis of **development in *Caenorhabditis elegans***, a microscopic soil nematode that serves as a model organism. Many of the developmental processes that C. elegans undergoes are analogous to processes in higher organisms, like humans. In particular, my lab is interested in the protein signaling pathways by which cells communicate in a multicellular organism. In addition to understanding how multicellular organisms develop, we hope to learn how fundamental cellular processes are altered to cause human disease.

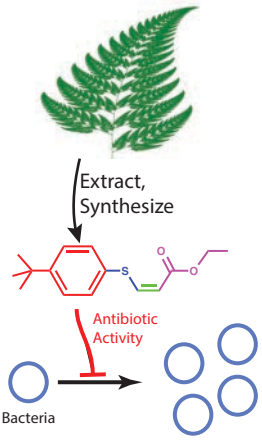
Chemical Biology and Medicinal Chemistry

The fields of Chemical Biology and Medicinal Chemistry are applied fields that use the tools of synthetic organic chemistry to design new molecules that interact with biological systems. These molecules are commonly used to probe or modify biological systems. In some cases the goal is to better understand how a biological system works. In other cases, the goal is to develop new drugs to treat disease. Academically, researchers in these fields are often found in chemistry, biology, or biochemistry departments. Industrially, this research is often done at pharmaceutical or biotech companies, with sizes ranging from small startups to some of the largest corporations in the world.

Aaron Monte

amonte@uwlax.edu

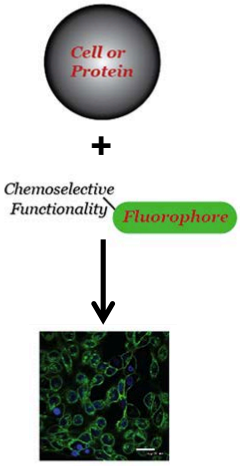
Researchers in my labs are involved in the application of organic chemistry methods to the **discovery, synthesis, and development of new drug molecules**. In one area, we are trying to build and improve novel anti-infective compounds derived from natural products. Specifically, we are making analogs of a natural product from the "sweet fern" plant that is used in traditional medicine by WI Native Americans. In another area, we are investigating the mechanism of action of psychedelic drugs and how they influence neurological function. We have prepared several unique rigid analogs of classic hallucinogenic phenethylamines. Most recently, we are focusing on the synthesis of novel anti-coagulants.



Nicholas McGrath

nmcgrath@uwlax.edu

The direct manipulation of biomolecules by chemical methods enables investigation of a great breadth of scientific questions, many of which are not accessible using traditional biochemical or genetic methods. For example, small non-natural tags for labeling or imaging cannot be manipulated using genetic methods alone. Developing chemistry to selectively modify biomolecules in an aqueous environment ("bioorthogonal chemistry") is challenging; reactions must be non-toxic, selective, and proceed rapidly. Research in my group is broadly focused on developing novel chemical reactions with azide and diazo compounds for attaching labels to biological molecules to investigate a myriad of cellular processes.



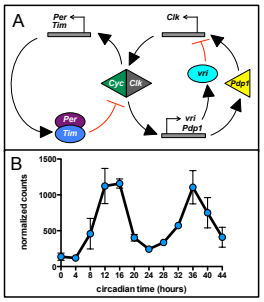
Genetics and Molecular Biology

Genetics and Molecular Biology faculty seek to understand biological processes through the study of biological macromolecules such as DNA, RNA, and proteins. These macromolecules store hereditary information, provide structure to cells, and serve many functions within the cell including transferring information, providing cell signals, transporting substances, and catalyzing chemical reactions. In addition to serving as an organism's genetic information blueprint, DNA also provides a molecular record of evolutionary history and demographic processes such as migration. Faculty in Genetics and Molecular Biology study a variety of subjects including the genetic basis of disease, the role of proteins in physiology and responses to the environment, molecular determinants of growth and development, molecular mechanisms of antimicrobial drug action, inferring evolutionary relationships and estimating species' migration patterns using genetic data, and using DNA to detect microbes in the environment.

Amy Yu

ayu@uwlax.edu

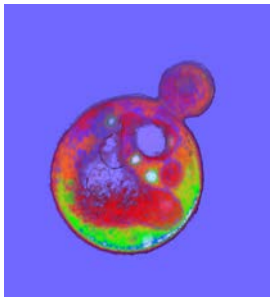
My research uses genetic and biochemical approaches to understand the mechanisms of circadian control of gene expression on a tissue specific basis. Many genes "cycle" between "on" and "off" at particular times of the day. Which specific genes cycle varies by cell type. I aim to determine which genes are under the control of circadian clocks running in the same tissue, and which genes are under the control of clocks from other tissues. I am interested in applying this to understand the health effects of shift work.



Anne Galbraith

agalbraith@uwlax.edu

We have recently taken on a new and exciting project that involves using yeast as a tool to characterize the effect of a patented antimicrobial discovered at UWL by my colleagues in Mycophyte. We are studying the effects of this antimicrobial on both mitotic growth and meiosis in *Saccharomyces cerevisiae* to help determine its mode of action.



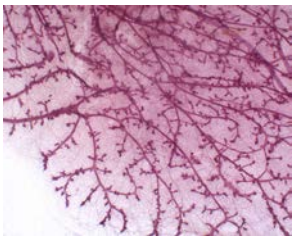
Michael Abler

mabler@uwlax.edu

Students in my lab use *Arabidopsis thaliana* as a model system to investigate the role of **RNA-degrading enzymes** in plant growth, development, and responses to the environment. Current projects include the genetic mapping of *arp* (altered RNase profile) mutations, cloning of mapped genes, the biochemical isolation and characterization of nucleases, and a project investigating ways to increase the frost tolerance of plants. Students use cutting edge techniques for mapping and cloning mutant genes, transforming (genetically engineering) plants, and characterizing proteins.

Paraic Kenny pakenny@gundersenhealth.org

Breast cancer is a complex disease with several different subtypes, each deregulated in distinct ways. We use human cell culture, patient specimens, and genetically engineered mouse models to try to better understand the molecular pathways disrupted in each breast cancer subtype with the overall goals of identifying new targets for therapeutic intervention, developing methods to inhibit these targets and elucidating biomarkers predictive of response to therapy. In parallel, we are studying the roles of several of these genes in normal mammary gland development and function.

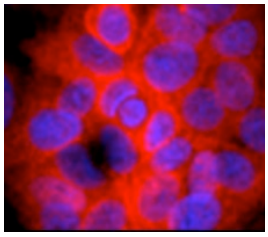


Scott Cooper scooper@uwlax.edu

My research focuses on using a variety of techniques to understand the effects of **hibernation on blood clotting.** Ground squirrels that hibernate have increased blood clotting times to prevent clots from forming as their hearts slow and blood pressure drops. Our lab uses molecular, biochemical, cellular and physiological assays to figure out how ground squirrels have adapted to these extreme physiological changes. This work also has clinical applications in the storage of platelets for transfusions and treating patients with heart disease and clotting disorders.

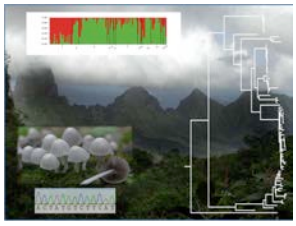
Sierra Colavito scolavito@uwlax.edu

Breast cancer is a leading cause of cancer-related death in women. Only a small subset of cells is thought to be able to initiate new tumor formation. These tumor-initiating cells may have markedly different drivers and responses to treatment compared to other tumor cells. My research investigates signaling activations that occur in these tumor-initiating cells in breast cancer. Specifically, I focus on a subset of breast cancer and seek to identify the drivers of the aggressiveness of these cells. This information could be used in the development of therapeutics and treatment regimens for patients with MSL or metastatic breast cancer.



Todd Osmundson tosmundson@uwlax.edu

Research in my lab uses both genetic and non-genetic (e.g., field surveys and morphological analysis) approaches to understand the biodiversity, biogeography, evolutionary relationships, community ecology, and conservation biology of microbial organisms, especially fungi. We study microbes in a variety of ecological roles and in uses such as biocontrol and bioremediation. Techniques and skills used in the lab include high-throughput DNA sequencing, phylogenetic analyses, population genetic analyses and computer programming, with transcriptomic and genomic studies planned for the near future.



Microbiology and Immunology

Research in microbiology and immunology focuses on diverse topics such as how the microbial population affects human health or how to develop new treatments for diseases.

Bernadette Taylor

btaylor@uwlax.edu

My research has involved development of tests for immune system function and response to infectious disease in several species, including cattle, marine mammals, ground squirrels and humans. This work involves development of monoclonal antibodies and their use in enzyme-linked immunosorbent assays (ELISAs), Western blots, and immunohistochemistry. Cell culture techniques are also important methods in my work. Current projects include studying human immune responses to low dose intradermal influenza vaccination and studying the effect of hibernation on the immune system of ground squirrels.

Bonnie Jo Bratina

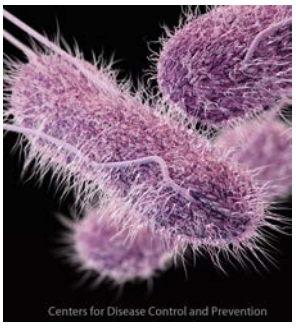
bbratina@uwlax.edu

My research interests center around looking at community diversity and interactions. One system we investigate is the microflora found in the intestinal tracts of aquatic slugs and ground squirrels. These organisms are identified using molecular phylogenetic analysis based on 16S rRNA sequence and traditional culturing methods. Another is how communities in the marsh have been affected by historic lead pollution and the resistance mechanisms they contain. Finally, we are also studying bacteriocin production by carnobacteria isolated from Antarctic lakes.

John May

jmay@uwlax.edu

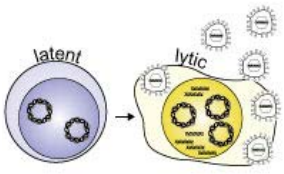
Carbohydrates on the surface of bacterial cells are critical for the ability of bacteria to cause infectious disease. My lab investigates **how bacteria regulate the chemical composition of surface carbohydrates**, with a focus on *Salmonella enterica*, a major bacterial cause of food-borne illness. Students in my group have the opportunity to learn techniques in biochemistry, enzyme kinetics, molecular biology, and bacterial genetics. My research can inform strategies to block key surface determinants of bacterial virulence.



Kelly Gorres

kgorres@uwlax.edu

Epstein-Barr virus (**EBV**) was the first virus discovered to cause a human cancer. During infection EBV switches between two phases of its life cycle. We are interested in molecules that reactivate the virus and how the process is inhibited. Our research investigates the interplay between the virus, the infected cell, and small molecules in the environment or drugs with the goal of developing strategies for treating virus-associated cancers. My lab spans virology, cell biology, biochemistry, and organic chemistry.



Marc Rott

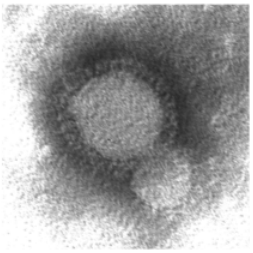
mrott@uwlax.edu

When not fishing, my research focuses on identification and characterization of **novel antimicrobial compounds** from plants and fungi. In collaboration with Dr. Aaron Monte from Chemistry, antimicrobially active extracts are separated to identify pure active compounds. Pure compounds are characterized for potency and spectrum of activity against a wide variety of microbes. Other recent projects include genomic mapping of bioluminescent bacterial species and the development of assays to detect *Mycplasma* ssp, an agent thought to be involved in sexually transmitted disease.

Michael Hoffman

mhoffman@uwlax.edu

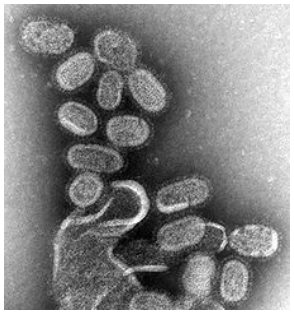
Research in my laboratory focuses on three areas of virology. 1) One focus is on **human parainfluenza virus type 3** (HPIV3), which infects children and can cause serious lower respiratory tract disease, yet there is no effective treatment or vaccine. Specifically, we are interested in how HIPV3 particles assemble and release from cells. 2) I also collaborate with the U.S. Fish and Wildlife Service to characterize **novel fish viruses** and assess the risk they pose to fish populations. 3) Finally, my lab also collaborates with other labs in Wisconsin to test plant-derived extracts for **antiviral activity**.



Peter Wilker

pwilker@uwlax.edu

My research aims to **understand the interplay between influenza viruses and infected hosts**. We are currently developing novel antibody reagents that will provide the basis for studying the immune response to influenza virus infection in ferrets, an important small animal model of human influenza infection. We also are studying the evolutionary dynamics that govern influenza host adaptation and the establishment of viruses that are capable of infection and transmission. Our work uses a variety of molecular and cellular approaches and employs massively parallel sequencing technologies to study low-level viral variation.

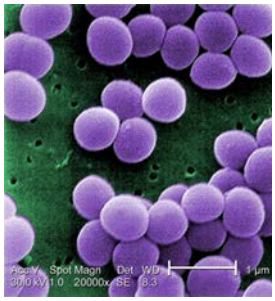


www.wikipedia.org

William Schwan

wschwan@uwlax.edu

Currently, I have three projects that I am working on: 1) Regulation of type 1 fimbriae in uropathogenic *Escherichia coli* I use genetic, molecular, and animal models techniques to explore the regulation of this virulence factor. 2) Drug discovery/preclinical testing I am collaborating with the Mycophyte Group at UW-L, Dr. James Cook at UW-Milwaukee, and Daniel Sem at Concordia University to try to bring new antibiotics through the pipeline. 3) *Staphylococcus aureus* drug persisters. This is a new area I am investigating that uses genetic, molecular, and animal models techniques to examine bacterial drug persisters.



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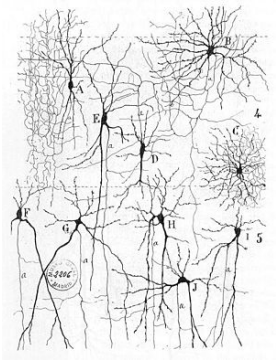
Physiology and Systems Biology

Physiologists study the function of body parts at the molecular, cellular, tissue, organ, organ system, and whole organism levels. Structure (anatomy) and function are entwined and molecular tools may be used to explore research questions at all levels of structure and function. Physiology research may address basic physiological mechanisms and/or be applied to develop and test applications for prevention, diagnosis, monitoring, and treatment of disease.

Bradley Seebach

bseebach@uwlax.edu

I am a developmental neurobiologist, interested in cellular **mechanisms of learning**, **formation and reconstruction of neuronal circuits**. Undergraduate research in my laboratory has focused on either (1) culturing mammalian neural stem cell-like cell lines, using growth factors common to natural nervous tissue development, or (2) characterizing mammalian spinal cord motor neurons during a critical, early stage of development using electrophysiological and histological research techniques. These research tracks are necessary to study the reconstruction of damaged nervous tissue using cellular implantation techniques.



Christine Schwartz

cschwartz@uwlax.edu

My research focuses on characterizing how the brain functions before and during hibernation in the thirteen-lined ground squirrel. During hibernation, the ground squirrels go through extreme changes in physiology, where the brain goes through periods up to two weeks with little oxygen or fuel! Humans would suffer extreme brain damage under these conditions, but the hibernating ground squirrel is naturally protected. Even more amazingly, parts of the hibernator brain still function during hibernation. I am interested in both how the ground squirrel brain is naturally protected and how it controls this unique phenotype.

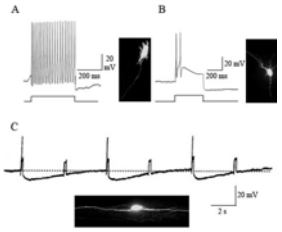
Margaret “Peg" Maher

mmaher@uwlax.edu

My research interests include: study of the hormonal regulation of appetite and metabolism and related disorders, as well as the health impacts of food components and additives and dietary supplements. Students may work with human subjects, animal models, or cultured cells in various types of observational or experimental studies associated with my laboratory.

Sumei Liu sliu@uwlax.edu

My research focuses on understanding the **neurophysiological** control of gastrointestinal functions in health and disease states. Functions of the gastrointestinal tract are largely controlled by the enteric nervous system, which is the only part of the peripheral nervous system that is capable of mediating reflex behavior in the absence of input from the brain and spinal cord. My goal is to understand how the enteric nervous system controls gastrointestinal motility, secretion, and epithelial barrier function in health and disease states.



Tisha King-Heiden tking-heiden@uwlax.edu

My research interests bring together a variety of disciplines: reproductive biology, developmental biology, endocrinology and toxicology. We study how exposure to endocrine disrupting compounds during early development influences health (primarily reproduction) later in life (**Developmental Basis for Adult Disease**), and strive to bridge the gap between ecotoxicology and human health. We use the zebrafish as a model organism as our findings are relevant to wild fish populations, as well as human health.