# Research Interests of Biology Faculty and Their Senior Project Students

**10** faculty members will be advising senior projects in the Biology Department in 2024-2025. They are: Drs. Coenen, Dawson, Demi, French, Hersh, Houtz, Humphreys, Kadmiel, Nelson, and Venesky. The research opportunities available in their laboratories, and the types of research activities that their senior project students typically pursue, are described below.

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**CATHARINA COENEN**

My research interests are in the biology of plants that provide food and medicine. Students in my lab have conducted research on the regulation of plant growth and development and on the interactions between plants and beneficial plant-associated microbes. More recently, we have been collaborating with students in Prof. Humphreys' group to investigate the role of microbes and plant-produced chemicals in controlling bean beetles, which are a major threat to food security. Finally, students who enter the lab with previous experience in microbiology have studied how microbes that are relevant to human health respond to plant-derived chemicals.

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**BECKY DAWSON**

My research draws primarily from epidemiological and biostatistical methods. I am specifically interested in understanding disease risk factors and patterns of disease in human populations. Work in my "lab" is not traditional wet lab work; instead, it involves collecting or using existing data from human participants. Student projects could involve secondary data analyses using data from the World Health Organization, Centers for Disease Control and Prevention, Pennsylvania Department of Health, or Meadville Medical Center. Alternatively, students can work on genetic epidemiology or disease transmission projects in addition to meta-analyses and other epidemiological research.

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**MICK DEMI**

My research focuses on the ecology of freshwater ecosystems and the organisms that inhabit them. I am particularly interested in how changing environmental conditions, including those related to human caused climate change, affect the structure and function of these ecosystems. My research interests span across levels of organization, from understanding the effects of environmental change on the performance, behavior and physiology of individual organisms (such as aquatic insects and fish), to understanding the factors that influence the fate of carbon and nutrients, such as nitrogen and phosphorus, in aquatic ecosystems.

Potential avenues of research for senior comp projects may include the effects of temperature on the physiology of aquatic organisms, the role of nitrogen and phosphorus in regulating important ecosystem processes such as decomposition, investigations of nutrient limitation of the growth of algae and aquatic

invertebrates and the role of nutrition in driving the feeding behaviors of aquatic organisms. Projects can be either field or laboratory based, depending on student interests. Focal organisms can be anything from algae to invertebrates to fish (or potentially amphibians).

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**LAUREN FRENCH**

My research interests fall under the general heading of Cellular and Molecular Neuroscience. I am interested in exploring what makes individual neurons unique from one another, how they "talk" to each other to transmit information in the nervous system, and how drugs and toxins affect their function. The projects in my lab involve both neurophysiology and molecular biology techniques.

Pharmacology is critical to the study of the nervous system; to learn how proteins such as ion channels contribute to normal function, and to discover the mechanism underlying pathological conditions. I am interested in how various chemicals- both natural toxins and pathogens as well as human-made compounds affect neuronal signaling by targeting ion channels. For example, one project involves a type of ion channel called the BK channel and its possible role in the pathology of Alzheimer's disease. The activity of this channel has been shown to be inhibited by a protein called Amyloid Beta. I'm interested in characterizing this interaction and discovering how the peptide affects the channel behavior. I am also pursuing how chemicals used as anesthetics may interact with ion channels.

Another line of research involves the crayfish as a model organism to study adult neurogenesis. We used to believe that the nervous system was only capable of producing new nerve cells during development, but we now know that neurogenesis is ongoing throughout animals' lifetime in certain areas of the brain. I am interested in studying the mechanisms underlying this process, and how it can be promoted or inhibited.

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**BRAD HERSH**

Though virtually all cells in an animal contain the same DNA sequences, different cell types (for example, muscle cells and nerve cells) have distinct physical properties. These differences are achieved during growth and development of the organism by switching on and off specific sets of genes within the common DNA sequence. Research in my lab encompasses two main areas:

1) Identifying and characterizing the DNA sequences that control when, where, and at what level gene expression is switched on and off in the developing animal body. The long term goal of this research is to understand the mechanisms by which Hox proteins, involved in shaping the head-to-tail patterning of all animals, regulate their target genes. We use the fruit fly, *Drosophila melanogaster*, to examine the DNA sequences that respond to the Hox protein Ultrabithorax and either activate or repress gene expression in the fly hindwing. We are also interested in identifying the genes, possibly targets of Hox proteins, that are important for differences between insect species to understand how evolutionary changes occur in the developmental processes that produce animal shape.

2) Characterizing the role of gap junction proteins in the immune response of the fly to various pathogens. The long-term goal of this research is to understand how cell-cell communication influences the innate immune response. The fly has genes for eight gap junction subunits, and we use molecular techniques to

increase or decrease their activity and determine the effect on survival of flies exposed to bacterial pathogens or parasitoid wasps.

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**JENN HOUTZ**

In an era of unprecedented climatic variability, organisms must express flexible phenotypes to persist in dynamic environments. My research focuses on how the physiology of wild animals interacts with their environment to influence their behavior and fitness. I'm interested in how physiological traits such as hormones (glucocorticoids, testosterone, estrogen) or the diversity of the gut microbiome responds to environmental stressors including extreme temperatures, food availability, or predation. I use a combination of field and lab techniques to address questions about physiology within an ecological context across biological scales. I primarily work with cavity-nesting bird species including tree swallows and Eastern bluebirds but I am open to working in other animal systems depending on students' interests and research questions.

Potential comp projects in my lab can include questions on how environmental or social factors impact physiology and behavior of wild and captive animals. Depending on the project, students in the lab will have the opportunity to learn field techniques such as banding, measuring, blood sampling, and behaviorally monitoring birds. Students will also learn lab techniques such as DNA extractions, PCR, hormone quantification, high-throughput sequencing, and metabolite assays.

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**TRICIA HUMPHREYS**

My research focuses on the obligate human pathogen *Haemophilus ducreyi*, which is most well known for causing chancroid, a sexually transmitted disease that is prevalent in resource-poor areas of the world. Previously, chancroid was of interest because it is associated with an increased risk of transmission and acquisition of the human immunodeficiency virus (HIV). More recently, *H. ducreyi* has been linked to limb ulcers in children in the Pacific Island Countries and Territories (Papua New Guinea, Solomon Islands, Vanuatu, Samoa, etc.). Students in my lab have studied the evolutionary relationships among isolates of *H. ducreyi*, differences in antibiotic susceptibility among isolates, and the potential to use essential oils as treatment for chancroid. My students are also interested in why more men than women have chancroid and they are trying to find out the biological basis for this sex bias. Furthermore, we are interested in figuring out why this organism that was previously thought to be only sexually transmitted is apparently being transmitted by some other, unknown, route. We address these questions with a variety of lab techniques, including DNA sequencing, classic bacteriology assays, bioinformatics, biochemical approaches, and work with biological vectors of disease. Please visit my website for more info about past and current research projects as well as my own research interests:
https://sites.google.com/a/allegheny.edu/humphreys/home

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**MAHITA KADMIEL**

Improved understanding of the molecular mechanisms of human diseases could lead to better diagnostics and treatment options. My research focuses on understanding how hormones work at molecular and cellular levels to coordinate various activities throughout the body. The hormones I am most interested in are glucocorticoids and their interactions with sex hormones (estrogen, progesterone and androgen).

Glucocorticoids (GCs) are primary stress hormones routinely used in clinical care for inhibiting inflammation (calming down the immune system) and for stopping the growth of new blood vessels. For example, GCs are used to treat diseases such as leukemia, asthma, eye infections, and diabetic retinopathy. Although synthetic GCs are life-saving drugs, there is a down side to them. Long-term use or high doses of glucocorticoids can cause adverse effects such as osteoporosis (brittle bones), cataract (cloudy lens), and glaucoma (optic nerve damage). The specific signaling pathways triggered or altered by GCs responsible for the beneficial as well as adverse events in different tissues of the body are not completely discovered. I am interested in elucidating the molecular actions of GCs in the eye using human cell lines from ocular tissues such as the retina and the cornea, and genetic mouse models of human diseases. Previous work has demonstrated that GC signaling through its receptor, the glucocorticoid receptor, is essential in mice for maintaining normal immune environment and vasculature in the eye and for the normal development of the eye. My current research plan is to investigate the molecular mechanism of GCs in the eye under systemic diseases or conditions such as diabetes and hormonal imbalances caused by menopause or endocrine disrupting chemicals in the environment.

A variety of techniques are employed in my lab including mammalian cell culture, cell death and cell viability assays, migration assays, dissections, RNA extraction, reverse transcription, quantitative polymerase chain reaction (PCR), signaling pathway analyses using bioinformatic programs, protein purification, western blots, tissue histology, immunofluorescence, microscopy, and imaging.

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**MARGARET NELSON**

I am interested in the way in which signal transduction pathways allow cells to interpret and respond to external cues during development. My research largely focuses on the role that the FbxA protein plays in the development of the eukaryotic social amoeba *Dictyostelium discoideum*. FbxA is a member of an evolutionarily conserved protein family that regulates cell behavior by targeting specific components of signal transduction pathways for degradation. Malfunctions in this degradation system have been implicated as a potential causative agent in several human diseases, including Alzheimer's disease, Parkinson's disease, and cancer.

One current area of interest is a possible role for FbxA in response to the signal molecule DIF, a chlorinated hexaphenone that acts to steer cells towards a specific subset of cell fates, in part by altering the subcellular localization of several transcription factors. Other projects have also begun to explore a potential role for FbxA in regulation of the cell cycle, an effect that seems to depend on FbxA-mediated ubiquitination and degradation of the cAMP phosphodiesterase RegA, and consequent alteration in the activity of PKA (cAMP-dependent protein kinase). The RegA-PKA circuit appears to be part of an evolutionarily ancient stress response mechanism that originally led to encystation of amoebae and has, more recently, been adapted to serve roles in differentiation and chemotaxis.

Data from former comp projects suggest that the FbiA protein may be another target of FbxA-mediated ubiquitination and degradation. Proteins homologous to FbiA are found in a wide array of eukaryotes, including fungi, plants, *C. elegans*, *Drosophila*, mice, and humans. The function of these FbiA

homologues is, however, unknown. Hence, further characterization of FbiA's role in *Dictyostelium* development (as well as that of its close homologue FbiB) may shed light on the function of another conserved protein family.

Several recent student projects have also employed *Dictyostelium* as a model system for analyzing other processes with human health ties such as chemotaxis (immune system, development, metastasis) and phagocytosis (immune system).

Depending upon the project you choose, you might employ any of the following techniques: restriction digests, agarose gel electrophoresis, plasmid & genomic DNA preps, PCR, introduction of recombinant DNA molecules into cells (bacteria, *Dictyostelium*), cell propagation & sterile technique (bacteria, *Dictyostelium*), protein purification, protein gels, Western blots, histochemical staining, spectrophotometric monitoring of β-galactosidase reporter activity, phase contrast microscopy, immunofluorescent microscopy, bright-field microscopy (stereozoom scope), or digital photography.

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**MATTHEW VENESKY**

The emergence of infectious diseases is one of the largest threats to human and wildlife health. The overall aim of my research is to better understand the consequences of parasite infection on wildlife and the cascading effects that parasites have on species interactions. I take a multidisciplinary approach to studying host-parasite interactions and I integrate molecular, physiological, and ecological approaches in my research. Student's in my lab interested in disease ecology conduct research using one of two different model systems: (1) amphibians and the fungal pathogen *Batrachochytrium dendrobatidis* ("*Bd*") or (2) ticks and the bacterium *Borrelia burgdorferi* (the causal agent of Lyme Disease). Using these host-parasite systems, we conduct lab-based studies examining how environmental, or physiological, factors affect infection outcomes and field-based studies that quantify parasites in natural environments. In addition to studying wildlife diseases, I have expertise in ecology and herpetology (the study of amphibians and reptiles) and students interested in general ecology also regularly conduct research in my laboratory. Please visit my website for more info about past and current research projects as well as my own research interests: https://sites.google.com/site/veneskylab/

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