Research Interests of Biology Faculty and Their Senior Project Students

Seven faculty members will be advising senior projects in the Biology Department in 2023-2024. They are: Drs. Coenen, Dawson, Humphreys, Kadmiel, Nelson, Venesky, and Whitenack. The research opportunities available in their laboratories, and the types of research activities that their senior project students typically pursue, are described below.

CATHARINA COENEN

My research focuses on the roles of the plant hormone auxin in growth and development and in the interaction between plant roots and soil microbes. My students and I have been characterizing the role of auxin in mycorrhiza, an agriculturally and ecologically important symbiotic association between plant roots and fungi. We have also begun to explore auxin as a communication signal between plant-protective bacteria and the roots these bacteria colonize. These projects have implications for organic agriculture, because the fungi and bacteria we study reduce the need for toxic fungicides and fertilizers.

The methods my students use to study auxin responses include genetics, molecular, biochemical and physiological experiments. As long as you enjoy working with plants, fungi, or bacteria, there are lots of different experimental approaches to choose from. Even if you may not be interested in staying in plant research in the long term, you will find valuable techniques and analysis methods to learn here that transfer to other systems.

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.

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 information about past and current research projects as well as my own research interests.

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.

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. We have also recently 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.

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.

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. Currently, most of the research in my lab falls under three general themes within disease ecology: (1) understanding the relationship between host physiology and disease risk, (2) identifying host traits that reduce, or amplify, pathogen transmission, and (3) surveying natural populations of aquatic vertebrates for parasites.

My laboratory is equipped to study various aquatic pathogens; however, most of my students work with amphibians and the fungal pathogen *Batrachochytrium dendrobatidis* ("*Bd*"). *Bd* is one of the deadliest organisms on the planet and it is linked to amphibian declines and extinctions on every continent except Antarctica. In addition to amphibians and *Bd*, my students and I have recently started studying ticks and Lyme Disease in PA. Although most of my own research is on wildlife diseases, I have expertise in ecology and herpetology (the study of amphibians and reptiles) and I can oversee comp projects that fall under numerous categories in these fields (i.e., you ***do not*** need to study infectious diseases to do your comp research in my lab!).

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/

LISA WHITENACK

My general research interest is on functional morphology, the relationship between form (shape) and function, in extinct and extant organisms – especially predator-prey relationships. My primary tool for this is biomechanics, the application of engineering techniques to determine how organisms perform mechanical functions, the design of morphological systems, and the relationship of these to the organism's

environment. My research generally concerns teeth and jaws of sharks and other fishes, the biomechanics of marine gastropods and their predators, and jumping mechanics of salamanders. The shape of an organism can also tell us about species relationships and ecology.

Potential comp projects in my lab could concern invertebrates or vertebrates; extinct or extant; biomechanics, morphometrics, or paleoecology. Previous comp topics in my lab include various fossil-related projects, sexual dimorphism in macaque monkeys and great horned owls, northern pike bite force, bluegill feeding kinematics, and biomechanics of various aspects of locomotion in fishes, lizards, frogs, salamanders, and humans. A complete list of comps from my lab can be found at https://sites.google.com/a/allegheny.edu/whitenack/student-research

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