Biology, Chemistry, and Physics
Faculty Research Interests

Revised 10/14/2010

DEPARTMENT OF BIOLOGY

Dr. Andy Ash: "Amphibian Biology"

The primary focus of my research is the effects of forest management techniques on populations of terrestrial salamanders in the southern Appalachian Mountains. It turns out these terrestrial salamanders are great indicators of the ecological health of forest litter, therefore helping to predict the return of ecological function to forests after tree harvest. Student opportunities: Fall/Spring (1) Summer (1)

Dr. Ben Bahr: "Therapeutic Treatments Against the Numerous Diseases that Disrupt Brain Function"

The 100,000 Gbyte hard-drive we call our brain is a challenge to study, also making it a challenge to find therapeutic treatments against the numerous diseases that disrupt brain function. In my lab, slices of brain tissue are kept alive to examine neuronal connections responsible for both memory encoding and cellular maintenance pathways, and to study their vulnerability to pathogenesis. While the brain's incredible density of synaptic connections allows for extraordinary memory capacity, the abundant synapses are also vulnerable to pathogenic over-activation. Such excitotoxic brain damage can occur in many disease states including stroke, traumatic injury, and seizure events. We are studying the pharmacological enhancement of endogenous pathways, and we found that positive modulation of internal repair mechanisms protects against the damaging effects of seizures and stroke-type excitotoxic insults. Other efforts are to study age-related neurodegenerative disorders. Every 72 seconds someone in the U.S. develops Alzheimer's disease (AD). Reducing Alzheimer-type protein accumulation is essential for slowing the progression of the disease. Lysosomes and their degradative enzymes (e.g. cathepsins) are known to respond to AD, perhaps in an attempt to offset the abnormal protein accumulations that cause a distinct pathogenic cascade. Recently, we discovered a new class of drugs that act as positive modulators of the lysosomal response, resulting in the up-regulation of cathepsins as well as neuroprotection in cultured brain slices and in mouse models of AD.

Dr. Liberty Carroll: "Developmental Biology, Neurobiology"

Molecules, genes and signaling pathways involved in axonal path finding and critical events in developing nervous system.

Dr. Wm. Bruce Ezell, Jr.: "Entomology"

My research concerns field studies of insects and their behavior patterns. I am interested in the host seeking behavior of deer flies and horse flies (Diptera:Tabanidae). I am curious as to exactly how these "micro-predators" locate us in order to seek our blood. Some of my other studies have centered around the effects of color and various hues and how they are perceived by these flies. I am also interested in the effects of dredging and dredged material disposal, as these procedures greatly enhance larval mosquito development. Dredge material disposal creates square miles of a man-made environment. I am also concerned with the use of weathering soil deposit patterns as indicators and predictors of mosquito ovaposition activity.

Dr. Deborah Hanmer: "Botany"

My training is in Plant Pathology. One current research project involves the interactions between a soil fungus and nematodes on tomato plants. Another interest of mine involves black soils form the Amazon call *terra pieta*. These fertile soils seem to be created using charred organic matter, and I have 2 students working on projects to determine the viability of using "biochar" to enhance the fertility of local soils. Student opportunities: Fall/Spring (2) Summer (TBD)

Dr. Leon Jernigan: "Environmental Biology"

Research area involves coastal marshes and freshwater wetlands. Topics of interest are hydrologic alterations, success of restoration/ mitigation projects, and environmental monitoring. Much of the expertise obtained by involved students would be in the area of applied ecology. Student opportunities: Fall/Spring (1) Summer(1)

Dr. Lisa Kelly: "Conservation Biology"

I'm a field biologist with research interests in the complementary fields of plant ecology, conservation biology, and plant taxonomy. More specifically, floristics, rare species, and the effects of natural and anthropogenic disturbances on plant diversity, interest me. As the director of the UNCP Herbarium, I have supervised and trained several students in standard herbarium techniques. I look forward to expanding the Herbarium's holdings and assisting students who are interested in the collection and preservation of voucher specimens. I have directed undergraduate research on *Chrysoma pauciflosculosa* (woody goldenrod), a state endangered species of plant. The work focused on population dispersion in the field and seed germination in the laboratory. I would enjoy assisting students in similar projects as well as in floristic studies in the future. Student opportunities: Fall/Spring (1) Summer (1)

Rachel McBroom: "Science Education"

Research interests include, 1) the use of computerized visualizations and animations to promote conceptual understanding of critical topics in science, 2) the use of teaching technology in K-12 science classrooms, and 3) inquiry-based teaching of science in K-12 classrooms. Also has expertise in training in the area of laboratory safety, especially as it relates to young scientists.

Dr. Maria Pereira: "Molecular Genetisc, biotechnology"

I have three different projects that students might want to participate. The first deals with biofuels and the production of biodiesel. This project is going to be performed in collaboration with Dr. Siva Mandjiny and Dr. Tom Dooling. Currently, UNCP owns a reactor in which kitchen oil can be converted into biodiesel. We are trying to find ways to use enzymes instead of the standard chemicals to make the reaction more efficient. One of the by-products of the reaction is glycerin. We need to find use for the glycerin. Students will have the opportunity to use their creative thinking, which is usually called "novel" research. The second project involves the growth and expression of eukaryotic cells and is going to be in collaboration with Dr. Jeremy Sellers. Human pancreatic cells (cancerous and control) will be evaluated and maintained alive in a CO2 incubator. We will be exploring different cell lines and looking for the mutations present. Techniques used include PCR, DNA sequencer, bioinformatics and cloning. The third project involves bacterial mutants. I have created E. coli mutants that are ampicillin resistant (no pAMP present). We need to evaluate these mutants and compare and contrast them for the physiological and biological characteristics. We are searching for the mutation present in each one by using the DNA sequencer and we will compare this mutation against all other known mutants by using bioinformatics. Student opportunities: Fall/Spring (2) Summer (2)

Dr. Robert Poage: "Neurobiology, Synaptic Physiology"

Synaptic transmission is the basis of all movement, sensation, and stimulation. My research involves ion channel function, primarily voltage-activated calcium channels. I am interested in specialization of neuronal membrane and how certain cellular compartments are capable of extremely rapid interneuronal communication. My primary training is in the use of electrophysiological recording techniques to study basic properties of neuronal communication. I am currently investigating the role of the presynaptic environment on voltage-gated calcium channel function using the frog neuromuscular junction as a model system. *We are currently addressing the following hypotheses: 1st, that DAP increases overall acetylcholine release while decreasing the effects of facilitation in LEMS conditions; 2nd, that DAP increases facilitation in LEMS conditions compared to control conditions.* Student opportunities: Fall/Spring (1) Summer (2)

Dr. John Roe, Wildlife Ecology

Research in my lab focuses on wildlife behavior, population biology, and ecology. Students that work with me will log many hours in the field using technologies to monitor populations and examine behavioral responses to environmental challenges such as climate change, habitat modification, roads, and pollution. Technologies that students will have the opportunity to use include radio-telemetry, global positioning systems, environmental data loggers, geographic information systems, automated recording devices, and others. I am particularly interested in reptiles and amphibians in the Lumber River and associated wetlands, the sandhills, and the unique depression wetlands known as Carolina Bays. I conduct basic descriptive research, but I also think it is important to apply research findings to addressing specific wildlife conservation and management issues.

Dr. Maria Santisteban: "Yeast Molecular Genetics, Epigenetic regulation of eukaryotic gene expression"

In the eukaryotic cell nucleus, DNA is packaged with histones into nucleosomes, the repeating subunits of chromatin. The precise organization of DNA in chromatin has important functional consequences. DNA-template processes such as transcription, replication and chromosome segregation are dependent on the remarkable packaging of the DNA in chromatin. The long-range objective of my research is to understand the molecular mechanisms of chromatin-regulated gene activation.

My research has primarily focused on the role a histone H2A variant, the H2A.Z/F. In the budding yeast *Saccharomyces cerevisiae*, this variant histone protein is encoded by the *HTZ1* gene. We have discovered that Htz1 functions to enable transcription by RNA polII. Specifically, our data indicates that Htz1 possibly plays a role in elongation. I would continue exploring this hypothesis using techniques of molecular genetics that will involve mutational analysis, genetic screens, chromatin imunoprecipitation, microarray analysis, Real-time PCR, etc. Student opportunities: Fall/Spring (2) Summer (2)

Dr. Marilu Santos: "Microbiology, public health and microbial genetics"

My research interest is focused on using the techniques of microbial and molecular genetics to explore fundamental processes in microbial cells as morphogenesis, pathogenesis, thermotolerance, metabolite production, antibiotic resistance ; biotechnology activities including development of strains for bioprospecting using molecular tools and public health related activities along the line of antimicrobial testing and establishing incidence of common pathogens in food, water, industrial products and relevant public places. Student opportunities: Fall/Spring (2) Summer (2)

Dr. Jeremy Sellers: "Lipid Biosynthesis, Immunology"

My research interests lie in developing a better understanding of lipid transport systems and the biogenesis of large lipid transfer proteins. We have recently shown that an ortholog of a factor involved in the formation of mammalian atherosclerotic lipoproteins is expressed in invertebrates. I wish to continue to explore the importance of this co-factor in invertebrate lipid transport systems and potentially relate this to the biogenesis of human atherosclerotic lipoproteins. Such research exposes students to multiple techniques in molecular and cellular biology as well as promoting an understanding of the basics of protein trafficking and the use of bioinformatics in research. Student opportunities: Fall/Spring (2) Summer (2)

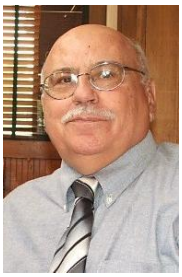
Dr. Patricia Sellers: "Environmental Biology and Chemistry, Lake/River Ecology, Water Quality Testing"

Research interests include metal and organic contaminants in lakes and river, eutrophication and water quality, processing affecting mass transfer of water constituents within and between ecosystems, microbial regulation of water chemistry, and applied research. Current work deals with a survey of the degree to which sediment and indicator species in the territory of Grassy Narrows First Nation (Ontario, Canada) contain elevated levels of mercury. Student opportunities: Fall/Spring (1) Summer (1)

Dr. Velinda Woriax: "Molecular Biology"

As a biochemist, my research interest includes a variety of topics: protein/protein interactions, enzymology, protein signaling, health issues of Native Americans, and science education among K-12. Currently at UNCP, our laboratory has begun a pilot study of isozymes found in a local evergreen shrub called *Chrysoma pauciflosculosa*. Undergraduate students are developing protocols to examine several isozymes of these populations for comparison between sites and within each population. Methods involved include electrophoresis using native acrylamide gels (native PAGE) and starch gel electrophoresis and molecular biology techniques. A second project involves the use of herbal extracts for antimicrobial therapy. Thus far, combinatorial and selected temperature and pH effects have been addressed with a student now attempting to determine effects on the bacterial morphology. It remains to be elucidated the thermostability of the extracts. Student opportunities: Fall/Spring (2) Summer (2)

DEPARTMENT OF CHEMISTRY AND PHYSICS



Dr. Jose D'Arruda: My research is in several areas:

- Quantum Statistical Mechanic-Solving Schrödinger Equation with various potential energy terms and applying the results to calculating correcting to the Ideal Gas law for high temperatures gases. These corrections lead to terms in the Virial Equation which gives us clues to the forces which exists between atoms and molecules in gases. Applications can be used to understand how stars evolve.

- Computational Physics-Using computer modeling to demonstrate to students and help them understand physical principles. Developing and deploying interactive models, simulations, and educational tools which improve math and science education through the effective use of modeling and simulation technologies.

- Robotics-Offering workshops using Lego NXT robotic kits to help teacher excite their students into learning science, math and engineering. Students compete in Robotic Games in the spring on our campus.

- Astronomy/Astrophysics- As director of the UNCP Space Grant I mentor several students each semester in various undergraduate research project in astronomy. Presently we are using our 16" GPS Meade telescope to measure the light intensity period of several Cepheid Variable stars as a way of determining their distance from the earth and performing spectroscopic measurement of several binary stars.

- Physics Education-Obtaining grants to offer workshops for teachers which will help them become better teachers of physics, physical science and astronomy.

- Science Fair- Having created the UNCP Regional Science fair 29 years ago I remain Co-Director with Drs Ritter and Postek.

Dr. William Brandon: "Physics, magneto-optics"

Recently, I have developed an interest in the field of magneto-optics. During the summer of 2008, two students and I acquired an absorption/fluorescence spectrometer and modified the apparatus to accurately characterize Faraday rotation, a phenomenon associated with the general area of magneto-optics. We are now able to measure the Verdet constant of transparent materials over a broad spectral range from the near UV (350nm) to the near IR (850nm). In the last year, considerable progress was put forth in

1. the design and construction of additional components
2. incorporating two benchtop instruments- best available in the industry
3. complete computer automation
4. calibrating the apparatus
5. developing rigorous data analysis algorithms
6. an exhaustive investigation of an "index normalized" dispersion of the Verdet constant of water allowing the calculation of the so-called, and somewhat controversial, band parameters

Confident that a world-class apparatus and corresponding methodology has been realized, we are now ready to embark upon investigations of the magneto-optical properties of novel transparent materials. The accuracy of the instrument will allow us to investigate thin films, which is important because novel materials can be expensive and thus sample size is limited by cost and/or difficulty in bulk-sized manufacturing.

Dr. Tom Dooling: "Physics, biotechnology"

I am currently involved in conducting student research as part of a NSF-REU grant in the Department of Chemistry and Physics. The focus of the Biotechnology project is to develop novel designs for radiological sensors. The goal of the project is to develop a software model for different sensor designs and compare that model with sensors designed and built in the laboratory which is inexpensive and efficient that would be used in the field to detect radiological sources that might be used for so called "dirty bombs;" devices that spread radioactive waste products in areas inhabited by people. My students also have the opportunity to attend conferences. Student opportunities: Fall/Spring (1) Summer (1)

Dr. Paul Flowers: "Analytical Chemistry; spectroelectrohemistry"

The term "spectroelectrochemistry" refers to the simultaneous application of spectroscopic and electrochemical techniques to investigate chemical reactions involving and/or related to electron transfer. Despite being extensively applied to studies of fundamental processes, spectroelectrochemical (SEC) methods have been infrequently employed for purely quantitative purposes (i.e., to measure the concentration of some substance in a sample). The use of SEC techniques for such analytical purposes is an attractive idea because of potential advantages in analysis time, cost, and selectivity. Previous work by our group in this area (*in vitro*) has involved the examination of the spectroelectro- chemical behavior of ascorbate and bilirubin, and preliminary results have been encouraging. Most recently, our group has begun the assembly and characterization of a microspectrophotometer that will be used to develop SEC assays for microliter samples. Student opportunities: Fall/Spring (2)

Summer (2)

Dr. Len Holmes: "Chemistry, biotechnology"

Much of my work at the university is related to regional economic development. Having created the UNCP Biotechnology Business and Training Center (www.uncp.edu/biotech), I am very interested in developing innovative ways to catalyze the development of biotechnology and other knowledge industries into rural Southeastern North Carolina. Working with biotech and other companies, universities and community colleges, I am focused on building the infrastructure for creating technology transfer through technology workshops and partnerships. This project is broad, and would be of great benefit to undergraduates giving them perspective on how the economy is tied to science/technology. Lastly, the biotechnology project collaborations with Dr. Mandjiny would be extremely benefited by the inclusion 1 full-time BS-level (perhaps Masters) laboratory technician. A second biotechnology project - Optimization of small-scale batch culture of marine actinomycetes:. The first order of business will be to learn about optimizing the growth conditions of the marine organism, *Actinomycetes*. The overall goal of the microbial fermentation component of the research will be to produce *Actinomycetes* expressing the desired product. Student opportunities: Fall/Spring (2) Summer (1)

Dr. Siva Mandjiny: "Chemistry"

Affinity separation has become the preferred method for purifying proteins and other macromolecules from complex biological fluids. It is a well established technique that continues to find new applications in pharmaceutical industries. Many types of molecules can serve as ligands including antibodies, antigens, enzyme inhibitors, receptors etc. Students will be engaged in research on affinity separation of proteins. This research will focus specifically on solid matrices such as membranes and gel beads. Membranes will include nylon and PVA etc., and gel beads will include Sepharose and silica. Membranes will be tested in filtration mode for the binding capacity of the protein and the gel beads will be tested in a chromatographic column for the binding capacity. The results obtained from this study will explain the comparative analysis of the membranes with the gel beads in terms of affinity constant and the adsorption capacity. The data will be useful in the downstream processing especially in the pharmaceutical industries. Student opportunities: Fall/Spring (2) Summer (1)

Dr. Mark McClure: "NMR Spectroscopy"

My research interests focus on the application of NMR spectroscopy to the study cobalt(III) coordination compounds containing multidentate ligands. These types of systems represent an interesting challenge from an NMR standpoint. For ligands that contain carbon atoms, C-13 NMR can sometimes be used to determine the overall geometry of the complex ion. However, the H-1 NMR of these systems is often complex. This complexity arises from the fact that coordination restricts rotation about the carbon-carbon bonds of the ligand and therefore introduces nonequivalence in hydrogen atoms attached to the same carbon. As a result, even a simple ethylene linkage joining two donor atoms can contain up to four nonequivalent protons. This often results in very complex splitting patterns, and the interpretation of such spectra requires two-dimensional NMR techniques such as COSY and NOESY. Student opportunities: Fall/Spring (2) Summer (2)

Dr. Tim Ritter: "Physics"

For the past three years I have been the faculty advisor for a group calling themselves "The Weightless Lumbees." The team of five undergraduate students has been conducting research as part of NASA's Reduced Gravity Student Flight Opportunities Program aboard their KC-135A aircraft (recently NASA has changed to a C-9 plane). The project is a joint endeavor between The University of North Carolina at Pembroke (UNCP) and The University of North Carolina at Charlotte (UNCC). This NASA program provides student teams, from around the country, with the chance to conduct research in the reduced gravity environment of the aircraft. The experiments are conducted in the rear of the jet aircraft while it undergoes a series of parabolic flight paths. During a portion of each parabola, approximately 20 seconds, the crew and experiments are in a weightless environment. Many interesting phenomenon occur in this environment that are impossible to observe in a normal 1-g laboratory setting. The most current project for the team is two fold. The first project investigates enzymatic activity in the different gravitational forces provided on board the aircraft. The results of this experiment will help in the understanding of the effects of varied gravitational forces on the body's enzymes. Specifically, the team has been looking at the reaction rates between a common enzyme and its related substrate to determine the gravitational effects on rate of reaction. The second experiment is dealing with the kinematics of inanimate objects (small spheres, cubes, cylinders) within a liquid. The objects will be of different shapes and sizes while the liquids will have different viscosities. The video record of this experiment, along with some simple calculations, will play a key role in our future outreach presentations. Student opportunities: Fall/Spring (1) Summer (2)

Dr. Rachel Smith: "Organic Synthesis and Biodiesel Productions"

I am currently working with the UNCP BioFuels team to optimize conditions for production of biodiesel from virgin oil using a heterogeneous catalyst. This process will then be used in a reactor prototype in order to demonstrate that farmers could grow oil seeds and produce their own fuels for farm equipment from the oil they grow.

My additional research interests are in developing new reactions of organic (carbon-based) molecules with the eventual aim of applying these new synthetic methods to the preparation of drugs.

- One important challenge in the chemical synthesis of drugs is stereocontrol. Just as our two hands are non-superimposable mirror images of each other, each chemical compound used as a drug also has a mirror image. Our bodies interact with these two mirror images in different ways. One way of controlling which hand of a product is formed is to use a chiral auxiliary, a temporary group added to a molecule which has it's own handedness. Part of my research involves using chiral auxiliaries in reactions to control the stereochemistry (handedness) of the reaction.
- Another research interest is focused on tandem cyclizations between unsaturated aldehydes and Meldrum's acid. Tandem means two processes happening in a row and in this reaction, there are actually two different reactions taking place consecutively.

Dr. Meredith Storms: "Analytical Method Development for Pharmaceuticals"

High-Performance Liquid Chromatography (HPLC) is often utilized to assay drugs in a variety of dosage forms and biological matrices, which is applicable to toxicology and the pharmaceutical sciences. Research in this area has included developing HPLC methods for selected compounds in several over-the-counter dosage forms such as common cough-cold preparations as well as intravenous admixtures and various biological matrices. In addition to HPLC and other analytical methodologies, the nature of this research often necessitates the need for an extraction procedure, thus, liquid-liquid (LLE) or solid-phase extraction (SPE) methods are typically employed for analysis. Through this research, students will be involved in the use of HPLC and SPE to determine the presence and concentration of pharmaceuticals in both dosage form and biological matrices while further strengthening their laboratory skills in a research environment.

Dr. Cornelia Tirla: "Organic Chemistry"

Biodiesel Production from Fatty Acids using Solid Acid Catalyst: Currently biodiesel is produced through the transesterification of waste vegetable oil using methanol and potassium hydroxide. Potassium hydroxide, once used in the reaction, is eliminated with the waste products. This can prove to be an expensive method of producing biodiesel as potassium hydroxide is not recovered from the wastes and a new batch must be added for subsequent reactions. This also sparks the debate as to whether or not biodiesel is a cost-effective and efficient fuel source when compared to fossil fuels. Solid acid catalysts are a possible solution to this problem. Removal of a solid acid catalyst is easier and the starting material is fatty acids instead of oil. This research will focus on the synthesis of biodiesel from fatty acids in the presence of solid acid catalyst. Student opportunities: Fall/Spring (2 ; Summer (2)

Production of Ethanol from Sweet Potato Remnants: Ethanol can be produced from large variety of biomass materials. The purpose of this project is to develop a protocol for the production of ethanol from sweet potato waste. As a starting point, the starch was hydrolyzed in acidic conditions and a glucose solution was obtained. The raw material is also a rich source of beta-carotene, a food supplement used in the cellular biosynthesis of the vitamin A. As part of this project, protocols will be developed to extract value added beta-carotene. In conclusion, this research addresses the increasing demand for alternative sources of energy and demonstrates complementary uses of agricultural waste biomass. Student opportunities: Fall/Spring (2); Summer (2)