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ABSTRACTS OF PAPERS PRESENTED AT THE 2007 MEETING OF THE TENNESSEE ACADEMY OF SCIENCE

BOTANY SECTION

REX BARBER, CHAIR

A REPORT ON THE ALL TAXA BIODIVERSITY INVENTORY AT MONTGOMERY BELL STATE PARK. ***LinnAnn Welch****, ***David R. Hill, and Jill Neblett***, *Tennessee State Parks, and Volunteer State Community College, Gallatin, Tennessee, and Belmont University, Nashville, Tennessee*. Previously established plots were inventoried to document the vascular flora of Montgomery Bell State Park, Dickson County, Tennessee. Initial studies began in 2005 with most work completed during the 2007 growing season. State park All Taxa Biodiversity Index (ATBI) protocol was followed with size classes used to collect woody species data and the point intercept cover method used to collect herbaceous species data. In the 7 plots studied, over 100 species of plants were documented including rare and endangered species such as Goldenseal (*Hydrastis canadensis*).

AN UPDATE ON THE FAMILY STYRACACEAE IN KENTUCKY AND TENNESSEE. ***Edward W. Chester***, *Austin Peay State University, Clarksville, Tennessee*. The distributional status of the three Styracacean taxa known from Kentucky and Tennessee is summarized. *Halesia carolina* is primarily an Appalachian species with numerous records from eastern Tennessee. The Tennessee River has apparently provided a migratory pathway for the species and it is known from most counties that border the Tennessee River in west-central and western Tennessee and Kentucky. However, it is otherwise rare in Kentucky and is considered an endangered species. *Styrax americanus* is widespread over both states, usually in lowland habitats. *Styrax grandifolius* is uncommon but scattered across Tennessee. There are four historic county records from east-central Kentucky, but these records have not been verified in nearly four decades and the species is not considered to be a part of that state's flora. Recent collections from Lyon County definitely add this species to the Kentucky flora, with vouchers at Austin Peay State University, Eastern Kentucky University, and the University of Tennessee. Listed status for *Styrax grandifolius* is appropriate for Kentucky.

CONSERVATION GENETICS OF AN ENDANGERED SUNFLOWER. ***Jennifer R. Ellis****, *Vanderbilt University, Nashville, Tennessee*. Studying the population genetics of endangered species is important because such populations are subject to a variety of genetic threats when they are rare. Applying population genetic techniques to endangered species also will increase our understanding of the genetic architecture underlying adaptive evolution. In my research, I will study an endangered sunflower, *Helianthus verticillatus*, to address population genetics and conservation biology questions. Here, I survey 22 EST-SSR's (Expressed Sequence Tag-Simple Sequence Repeat) developed for *H. annuus*, in *H. verticillatus* and a common congener, *H. angustifolius*, for genetic diversity and population differentiation. I find that the rare sunflower does not have lower genetic diversity than its common relative. I conclude that *H. verticillatus* is not a hybrid as it does not exhibit a mixture of parental alleles at nuclear loci.

A PRELIMINARY FLORA OF THE NORTH CHICKAMAUGA CREEK GORGE STATE NATURAL AREA. ***Stacy Huskins**** ***and Joey Shaw***, *University of Tennessee, Chattanooga, Chattanooga, Tennessee*. The North Chickamauga Creek Gorge State Natural Area (NCCG) consists of 4,864 acres and is located in Hamilton and Sequatchie counties in eastern Tennessee. The NCCG is on the eastern edge of the Cumberland Plateau and is bordered by the Ridge and Valley physiographic province. Broadly defined habitat types support a diverse assemblage of plants on the NCCG 's upper plateau surface, gorge slopes, stream banks, and ruderal areas. Floras of nearby areas comprised of similar habitat types have reported over 1,000 species. Ten species with either a state or federal listing are known to occur in the NCCG: *Scutellaria montana*, *Spiraea virginiana*, *Nestronia umbellula*, *Phemeranthus mengesii*, *Sabatia capitata*, *Diervilla sessilifolia* var. *rivularis*, *Lonicera dioica*, *Panax quinquefolius*, *Viola tripartita* and *Glyceria acutifolia*. Twenty collecting trips were made during the spring and early summer of 2006 and 180 species of vascular plants in 72 families were documented, including several populations of *Scutellaria montana*.

CHESTNUT AND CHINQUAPIN HYBRIDS ARE CONFOUNDING TAXONOMY: A DNA SEQUENCE-BASED INQUIRY INTO A PUTATIVE HYBRID POPULATION. ***Meagan Binkley****, ***Hill Craddock, and Joey Shaw***, *University of Tennessee, Chattanooga, Chattanooga, Tennessee*. In North American, *Castanea* L. (Fagaceae) consists of three morphologically variable species: *C. dentata*, *C. pumila* and *C. ozarkensis*. In the southeast there has been reported a naturally occurring *C. pumila* × *C. dentata* hybrid (*C. neglecta* Dode). However, it is possible that the putative hybrids may be either disjunct *C. ozarkensis* populations or North American-Eurasian hybrids introduced during a breeding program in the mid 1900's. We are using chloroplast DNA sequences to test a morphologically confounding population in northwestern Georgia in comparison to a population in western North Carolina where morphologically distinct *C. pumila* and *C. dentata* occur in sympatry. Preliminary results indicate that the chestnut and chinquapin chlorohaplotypes are not confined to species. Future work will include additional populations and the exploration of other genes.

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THE BOTANY SECTION OF THE TENNESSEE ACADEMY OF SCIENCE, 1934–2007. ***T. Hemmerly, J. Butler, and J. Corgan***, *Middle Tennessee State University, Murfreesboro, Tennessee (TH) and Austin Peay State University, Clarksville, Tennessee(JB, JC).* Oral presentations to the Tennessee Academy of Science botany section for 1987–2007 were compared with those of 1934–1986. For each of these time periods, approximately one-half of the papers were devoted to angiosperms with the remainder divided among gymnosperms, ferns, bryophytes, algae, bacteria, and fungi. Among the subdisciplines of botany, emphases of papers presented each period were focused primarily on physiology, ecology, and plant distribution, with fewer papers concerned with taxonomy, morphology, and reproduction. However, there was a considerable increase for the former period in the number of papers on ecology with a corresponding decrease in those on physiology and distribution during the latter period. Although varying greatly from year to year (3–18), the mean number of papers per decade has remained remarkably constant over the 73 years.

SPATIAL ANALYSIS OF INVASIVE WETLAND PLANT SPECIES IN THE SOUTHEAST USING GEOGRAPHIC INFORMATION SYSTEMS AND HERBARIUM SPECIMENS. ***Ryan Miller****, ***Andrew Carroll, and Joey Shaw***. *University of Tennessee, Chattanooga, Chattanooga, Tennessee.* The extensive data inherent in herbarium specimens can be used to reconstruct the spread of invasive wetland plant species. Using a network of collaborative herbaria (SERNEC), spatio-temporal data were obtained and analyzed in Geographic Information System (GIS) to study the spread of invasive wetland species throughout the southeast. Three invasive wetland plant species were used in this study: *Phragmites australis*, *Lythrum salicaria*, and *Rorippa nasturtium-aquaticum*. In the first method, invasive records within the southeastern United States were used to generate 25 km "occupied areas"; the increase in area over time was analyzed to examine coarse geographic spread. The second method focused on specific study areas of interest within the southeast where collection density was highest. Comparisons of occupied 10 by 10 km cells over time in these high density areas were used to proportionally compare the records of invasive species to the sampling efforts of their native associates over time and space.

ECOLOGY OF SURVIVING AMERICAN CHESTNUT (*CASTANEA DENTATA*) TREES ON THE WESTERN EDGE OF THEIR FORMER RANGE IN MISSISSIPPI, KENTUCKY, AND TENNESSEE. ***Louis J. Schibig***, *Volunteer State Community College, Gallatin, Tennessee.* From 2002 to 2007, 139 native American chestnut (*Castanea dentata*) trees were inventoried west of the Tennessee River—6 in 2 Kentucky counties, 16 in 2 Mississippi counties, and 117 in 7 Tennessee counties. Coordinates for each chestnut specimen, site conditions, measurements of stem dbh and height, blight status, flowering status, associated tree and shrub species, and other data were entered into an Excel spreadsheet and analyzed to determine size class distributions, site preferences, and the incidence of blight and flowering. Most were blight-free, less than 2.5 cm dbh, and under 3 m in height; the largest was found in Weakley County with a dbh of 35 cm and a height of 17 m. Only two were flowering. The chestnut trees were most often on dry, acidic, sandy, well-drained soils growing in association with *Quercus alba*, *Q. coccinea*, *Q. velutina*, *Oxydendrum arboreum*, *Carya glabra*, *Nyssa sylvatica*, *Amelanchier arboreum* and *Vaccinium* spp.

THE AMERICAN CHESTNUT BACKCROSS BREEDING PROGRAM IN TENNESSEE. ***S. Clark Cropper***, *Volunteer State Community College, Gallatin, Tennessee.* In May, 2007, the Tennessee Chapter of The American Chestnut Foundation (TACF) established its seventh backcross orchard in Monroe County, Kentucky. This orchard is part of TACF's ongoing program to backcross Chinese chestnut (*Castanea mollisima*) resistance to the chestnut blight fungus (*Cryphonectria parasitica*) into American chestnuts (*Castanea dentata*). Sixty-eight hybrid American/Chinese (BC3) chestnut seeds were planted. These hybrids represent two family lines (TNMON8 × CH34) and (TNMON4 × IL332) of twenty lines in development by TACF. Survivability in this orchard has been excellent to date. Twenty-five of twenty-eight (89%) TNMON8 × CH34 and thirty of forty (75%) TNMON4 × IL332 hybrids have survived 22 weeks of growth. Twenty trees are more than 60 cm tall. Trees surviving after three years will be inoculated with the chestnut blight fungus. Progeny of moderately blight resistant trees will be used in future crosses to develop strongly resistant trees.

A RETROSPECTIVE OF VOLUNTEER STATE COMMUNITY COLLEGE'S PARTICIPATION IN THE ALL TAXA BIODIVERSITY INVENTORY AT EDGAR EVINS STATE PARK. ***Robert R. Barber***, *Baylor University, Waco, Texas.* The Tennessee State Parks All Taxa Biodiversity Inventory (ATBI) was implemented with the intent of documenting all species of flora and fauna currently existing in the 56 Tennessee State Parks. Since 2004, Volunteer State Community College has had an active roll in documenting flora existing at Edgar Evins State Park, Dekalb County, Tennessee. This park consists of 2,711 ha (6,700 acres) and surrounds Center Hill Lake. The park area was formed by annexation during the late 1940's coinciding with completion of Center Hill Dam on the Caney Fork River. Edgar Evins State Park was officially opened in 1975. Ten 20 m by 50 m permanent plots have been established in diverse topographical locations. Dendrological surveys of the ten plots have been accomplished and documented. Importance Values (IV) will be reported for stems > 10 cm as well as class sizes for woody shrubs < 10 cm. *Juniperus virginiana*, *Fraxinus Americana*, *Quercus muehlenbergii*; *Liriodendron tulipifera*, *Carya glabra*, *Celtis occidentalis*; and *Acer saccharum*, *Ailanthus altissima*, *Sassafras albidum* are a few of the forest communities documented. Evidence that current forest composition and communities are impacted by historical anthropogenic disturbances in the Caney Fork River Valley also will be discussed.

DIVERSITY OF SOIL BACTERIA AROUND NATIVE AND EXOTIC PLANTS. ***Amy Nause**** ***and A. Darlene Panvini***, *Belmont University, Nashville, Tennessee.* The introduction of exotic plant species into an area can significantly alter the diversity and composition of the soil bacteria community. Three sites at Warner Parks, Nashville, Tennessee were identified as having areas significantly covered by exotic *Lonicera maackii* as well as areas containing only native species. Six soil samples were taken from each site, three under the *Lonicera* and three under native species. The soil samples were diluted and plated on nutrient agar to grow bacteria. Each bacterium was isolated and re-plated to grow pure colonies. Colony color, shape, and margin description were used along with Gram staining and bacteria

shape to identify the bacteria present in the soil samples. Preliminary results suggest that more bacteria types were present in the soil samples underneath *Lonicera*. The ecological significance of changes in bacterial communities in relation to the presence/absence of exotic plant species will be considered.

INSECT HERBIVORY ON EXOTIC VINCA AND NATIVE GOLDENSEAL. ***Annie Lou M. O'Steen* and A. Darlene Panvini***, *Belmont University, Nashville, Tennessee*. Preliminary studies in Warner Parks, Nashville, Tennessee during 2006 suggested that levels of herbivory on exotic species were less than those on native species. The current study examined levels of insect herbivory on exotic vinca and native goldenseal plants by counting the number of leaves with herbivory and assessing the percent leaf area chewed by insects. Leaves of both species were collected, scanned, and digitized so that leaf surface areas of the digital images could be measured using ImageJ. Insects were collected using pit-traps and sweep nets in the areas underneath and around the plants to determine potential insect herbivores. Goldenseal had significantly more leaves and greater surface area affected by herbivory. Diversity of insects found around the plants varied slightly. The impact of exotic plant species on insect diversity and overall ecological processes will be considered.

ENHANCED NONPHOTOCHEMICAL DISSIPATION OF EXCITATION ENERGY DURING THE DEVELOPMENT OF PHOTOCHEMISTRY IN *SELENASTRUM CAPRICORNUTUM*. ***John E. Greenman* and Jefferson G. Lebkuecher***, *Austin Peay State University, Clarksville, Tennessee*. The rate of cell division during exponential growth of the unicellular green alga *Selenastrum capricornutum* (Printz) exceeds the rate of photochemical development. The hypothesis that excess absorbed irradiance is dissipated by nonphotochemical transduction during exponential growth was tested by measuring chlorophyll *a* fluorescence transients. Cells in the stationary and exponential growth phases exhibited optimal quinone-reduction potential by photosystem II. Cells in the exponential phase dissipated a significantly greater amount of absorbed light energy by nonphotochemical transduction relative to cells in the stationary phase. The results indicate that during exponential growth, the capacity for quinone reduction exceeds the capacity for quinone oxidation, and that nonphotochemical transduction of excess absorbed light energy limits quinone reduction prior to the development of full photochemical potential.

CELL AND MOLECULAR BIOLOGY SECTION

NICK RAGSDALE, CHAIR

APOLACTOFERRIN INHIBITS A LOW MOLECULAR WEIGHT ISOFORM OF MATRIX METALLOPROTEINASE-2 BY A ZINC CHELATION MECHANISM. ***A. L. Newsome, J. P. Johnson, R. L. Seipelt, and M. W. Thompson***, *Middle Tennessee State University, Murfreesboro, Tennessee*. Matrix metalloproteinase-2 (MMP-2) and lactoferrin (LTF) are proteins implicated in regulating inflammation. Since the secretion of both proteins is elevated during sustained inflammation, the effect of LTF on the proteolytic activity of MMP-2 was examined. Apolactoferrin (ApoLTF), but not iron-saturated LTF (HoloLTF), reduced the hydrolysis of a peptide substrate by the 42 kDa fragment of MMP-2, but not the 66 kDa form. $ZnCl_2$ and $FeCl_2$ were added to the reaction to determine the mechanism. Addition of Zn^{2+} but not Fe^{3+} restored MMP-2 activity. Furthermore, pre-saturation of LTF with Zn^{2+} eliminated its inhibitory activity, indicating that ApoLTF may chelate zinc from the MMP-2active site. The relatively low zinc affinity of the 42 kDa MMP-2 isoform and the strong temperature dependence of the interaction further indicate that the accessibility of the MMP-2 active site is crucial to this novel regulatory mechanism.

DEVELOPING AND EVALUATING MOLECULAR METHODS FOR DETECTING THE AMPHIBIAN-CIDAL FUNGUS, *BATRACHOCHYTRIUM DENDROBATIDIS*. ***David C. Henley*, Betsie B. Rothermel, and Chad S. Brooks***, *Austin Peay State University, Clarksville, Tennessee*. *Batrachochytrium dendrobatidis* (Bd), also known as Chytrid fungus, is believed responsible for world-wide amphibian decline. Recent studies have shown that Bd was found on the eastern and western coastal regions of the United States, threatening local amphibian populations. Current methodologies used to identify Bd infected amphibians require swabbing frogs and/or dissection of frog tissues followed by real-time polymerase chain reaction (RT-PCR) using Bd-specific primers. This study shows conventional PCR techniques are adequately effective at detecting Bd infected tissues. Bd-specific PCR methodology will be discussed. Additionally, novel methods using Bd-specific antibodies to enhance PCR detection will be discussed.

NOVEL MICROMIRRORS TO OBTAIN THREE-DIMENSIONAL IMAGES OF CELLS.. ***Charles S. Wright*, Erik M. Boczko, John P. Wikswo, and Kevin T. Seale***, *Vanderbilt University, Nashville, Tennessee*. Confocal scanning laser microscopy and multiphoton microscopy provide 3D data from biological specimens, but with limited z-axis precision. We are developing a system that uses multiple microscale mirrors to obtain more accurate 3D data on living cells while using classical widefield microscopy. Etched silicon wells coated with aluminum have been used to obtain 3D images of pollen grains and protozoa. Reflections from the angled sides of the well provide information along the z-axis, and a back-projection algorithm can be used to reconstruct a 3D image. We are optimizing this system to measure the volume of an individual budding yeast cell as it progresses through the cell cycle. This cell's roughly prolate spheroidal shape gives data suitable for fitting to a simple 3D surface, whose integration provides the volume. We are also forming a mirrored well on the end of an aluminum rod that can be positioned optimally above a cell.

PINOCYTIC LOADING OF PRIMARY T CELLS. ***John Wikswo, Kevin Seale, and Mary A. Marschner****, *Vanderbilt University, Nashville, Tennessee*. Pinocytic loading is one successful method to move desired substances into the cytosol of a cell. The project's objective was to continue the study of pinocytic loading in microfluidic devices and to extend the study from Jurkat T-cells to primary T-cells. Using a system of pumps to alternate the environment within the microfluidic device, the cells were subjected to three cycles alternating normal media and fluorescent hypertonic media. During the experiment images were taken using Metamorph and uptake of fluorescent dye into the cytosol of primary T-cells was shown. ImageJ was used to analyze the images taken during the experiment and an average

difference between the background fluorescence and the fluorescence of the cells was 12.38 after the first cycle, 11.29 after the second cycle, and 15.27 after the third cycle was found. There was an increase in fluorescence in the primary T-cells. However, it was not as pronounced as was seen in Jurkat T-cells.

TOXICOLOGY STUDIES USING MICROFLUIDIC DEVICES AND T CELLS. ***Priya G. Sivasubramaniam****, *Vanderbilt University, Nashville, Tennessee*. Microfluidic devices were used to trap primarily Jurkat cells, inject a given toxin, and observe its effects upon individual cells. This is key as although several effects are known on a macroscopic scale in regards to these toxins, little is known on a one-cell, microscopic scale. I have been working with Jurkat and primary cells in regard to formaldehyde fixation and post fixation motility and membrane permeability effects using a DAPI nucleus stain. I am now focusing on an allegedly fatal gastric toxin and its effects on Jurkat and primary T-cell motility and size, using a student designed MATLAB algorithm to numerically quantify results. Temperature controls may be an additional factor in these experiments. These gastric experiments will continue the heavy utilization of microfluidic devices.

BLOOD SEPARATION IN MICROFLUIDIC DEVICES. ***Eric Chung*, Kevin Seale, and John Wikswo***, *Vanderbilt Institute for Integrative Biosystem Research and Education, Nashville, Tennessee*. Microfluidics is a relatively new area of science used in measuring biomedical signals. Blood cells were trapped and then separated. The difficulty in this experiment is that trapping cells requires an extreme amount of precision. To add to the difficulty, the experiment focuses on separating white and red blood cells within the device. The device is capable, with the correct trap size, of trapping white blood cells and allowing red blood cells to flow through. The results show it is possible to trap white blood cells selectively. The second part of the experiment is focused on creating single cell measurements and determining cell characteristics. By obtaining fluorescently marked clusters of differentiation (CD) markers, the strength of markers and fluorescents could be observed for cells that contained specific CD. Markers displayed greater fluorescence when bound and were easily distinguishable from the media the cells were suspended in.

A LOOK AT SOME STATE-BASED OBESITY PREVENTION AND MANAGEMENT PROGRAMS FOR CHILDREN AND ADOLESCENTS. WHAT LESSONS CAN TENNESSEANS LEARN? ***Eleanor K. Jator***, *Austin Peay State University, Clarksville, Tennessee*. Studies show there is an increase in the number of obese and overweight children in the United States. There are also reports on some successful tailored prevention and management programs involving the whole family in some states. In this paper, some community based prevention and management programs adopted by several states are discussed. Many of these state programs addressing this obesity crisis create new prevention programs or are licensees of existing community based obesity prevention and management programs established in other states. There is no known family oriented obesity prevention and management program in Tennessee addressing adolescents and children. Recommendations on how Tennessee can address this issue are discussed. A statewide program that addresses childhood obesity is important since this chronic condition not only leads to many diseases but also leads to high healthcare costs and this condition persists in adulthood.

A COMPARISON OF VISUAL VERSUS OLFACTORY CUES FOR MATE SELECTION IN ZEBRAFISH, *DANIO RERIO*. ***Zachary W. Caro* and Lori L. McGrew***, *Belmont University, Nashville, Tennessee*. The aim of this study is to gain a more detailed understanding of mating cues observed in *Danio rerio*, zebrafish; specifically visual and olfactory cues. Previous studies have shown that courtship behaviors may be induced by different cues including chemosensory, olfactory, and visual cues. However, few studies have been done on the different roles of these cues and the effects they have on males. Other studies also show that pheromones are responsible for kin recognition among zebrafish. This study examines the role of these cues in mate selection among zebrafish by using three different phenotypes (striped, leopard and pearl) to determine whether there is a preference based on the phenotype of the fish exhibiting the cue. This study may demonstrate the importance of visual and olfactory cues in both initiating a mating response (recorded by male courtship behavior) as well as the final outcome of mating (measured by egg production).

THE EFFECTS OF CAFFEINE ON LEARNING IN ZEBRAFISH, *DANIO RERIO*. ***Adam Gilliland* and Lori L. McGrew***, *Belmont University, Nashville, Tennessee*. Zebrafish (*Danio rerio*) have long been used as a model organism in cellular and developmental biology. Recently, researchers have begun to study zebrafish behaviors. A number of experiments have characterized the effects of certain drugs on zebrafish embryos. Caffeine, however, has not been studied in zebrafish. Considering the prevalence of caffeine in America, and its potential to increase attention and focus in humans, it is a logical step to determine whether caffeine can facilitate learning in zebrafish. Fifteen wild-type zebrafish where given varying doses of caffeine, ranging from 0 to 10 mg/L. The fish were then tested using a rapid conditioning paradigm, to see whether the caffeine affected their learning ability in regards to avoiding a negative reinforcement. The results suggest that caffeine did not affect zebrafish learning. The doses of caffeine may have been too high based on physiological changes in the fish.

NICOTINE FACILITATES LEARNING IN ZEBRAFISH, *DANIO RERIO*. ***Rebecca L. Repasky* and Lori L. McGrew***, *Belmont University, Nashville, Tennessee*. Losses in memory have been a devastating reality for millions of Americans, especially with modern increases in age and the onset of neurodegenerative diseases such as Alzheimer's disease. Studies have shown that in many model systems, nicotine increases memory. A recent addition to the group of standard models is the zebrafish *Danio rerio*, a small fish used traditionally in the studies of developmental biology and genetics. In our study, the fish were tested using a rapid-conditioning test to observe learning of side-preference in a tank. Previous studies used the salt nicotine ditartrate in their tests. However, to standardize results, this study used pure nicotine. Results revealed a dose-dependent curve, with optimum concentrations providing higher learning in treated than in control fish. We also determined that long-term exposure to nicotine produced results no different from fish not exposed to nicotine, suggesting the development of tolerance to the chronic presence of nicotine.

ROLE OF SEROTONIN IN CAFFEINE-INDUCED LOCOMOTORY CHANGES IN *CAENORHABDITIS ELEGANS*. ***Jelena Stupar* and Lori L. McGrew***, *Belmont University, Nashville,*

Tennessee. Caffeine is one of the most commonly used addictive substances among humans. However, there are relatively few studies demonstrating how caffeine affects humans. Caffeine consumption results in desensitization to endogenous neurotransmitters, creating dependence. Caffeine affects a number of neural pathways in humans, and this complexity makes it difficult to determine the exact mechanism of action. *Caenorhabditis elegans* are a simple model system that makes examining neurological pathways easier and demonstrates similarity to the neurological pathways in humans and other animals. Previous studies have demonstrated that caffeine works as an adenosine receptor antagonist, thereby affecting adenosine-modulated serotonin release. Based upon this and the role of adenosine in *C. elegans*, we predicted that caffeine would affect nematode locomotion and chemotaxis. We used image capture and analysis software to characterize movement in worms treated with caffeine and compared them to untreated controls.

CHARACTERIZATION OF "SHRINKER" MUTANTS IN *CAENORHABDITIS ELEGANS*. ***Bethany N. Woodard* and Lori L. McGrew***, *Belmont University, Nashville, Tennessee*. This study utilized the nematode, *Caenorhabditis elegans*, a widely used model organism in neuroscience. A wild-type strain, N2, and two mutant strains, *unc-46* and *unc-25* were characterized. The mutant strains have a shrinker phenotype which is caused by a mutation in GABA receptors. Shrinker worms are shorter than wild type worms and cannot move effectively; they lack sinusoidal movement. In collaboration with the computer science department, we used image capture and analysis to evaluate movement deficits in these mutants. Following characterization of the animals, we treated the nematodes with muscimol (a GABA receptor agonist) and β-alanine (a GABA transporter blocker) and evaluated the efficacy of these agents to restore wild type function. The untreated *unc-46* mutant worms showed statistically significant differences in length when compared to N2 worms. Following treatment with muscimol, the *unc-46* mutants showed a significant increase in length. β-alanine however, had no significant effect on the mutant worms.

SEQUENCING CANDIDATE GENES FOR DROUGHT TOLERANCE IN ALFALFA (*MEDICAGO SATIVA* L). ***Sherly I. Celada****, ***Rachel H. Lovett****, ***and Mary K. Sledge***, *Lipscomb University, Nashville, Tennessee*. Drought stress is the most significant environmental stress factor limiting United States crop production. Alfalfa, the fourth largest crop grown in the United States in terms of acreage, exhibits reduced crop yields and limited persistence in response to drought. In a preliminary study, 412 drought-induced and 111 drought-repressed genes were identified by probing *Arabidopsis* and *Medicago truncatula* microarrays with mRNA isolated from control and drought stressed alfalfa. Differentially expressed feature sequences were aligned with sequences from the *M. truncatula* database in The Gene Index Project (formerly TIGR) using the BLAST tool. The *M. truncatula* DNA sequences identified were used to design gene specific primers. The PCR products obtained from two alfalfa genotypes (parents of a drought tolerance mapping population) were dideoxy sequenced. Sequence differences among the parents will be used to design single nucleotide polymorphism (SNP) markers for genotyping the drought tolerance population to identify Quantitative Trait Loci (QTL) for alfalfa drought tolerance.

DIFFERENTIAL LOCALIZATION OF MATRIX METALLOPROTEINASE-2 ISOFORMS IN AUTOIMMUNE THYROID TISSUE. ***N. Mohyuddin* and M. W. Thompson***, *Belmont University, Nashville, Tennessee and Middle Tennessee State University, Murfreesboro, Tennessee*. Recent evidence suggests a catalytic domain fragment of matrix metaloproteinase (MMP-2; 42 kDa), but not the full-length form (62 kDa), is inhibited by lactoferrin. The hemopexin domain (20 kDa), from the 62 kDa domain, disrupts integrin signaling. Little is known regarding the extent of breakdown of active 62 kDa MMP-2 in normal or diseased tissue. Normal and autoimmune thyroid tissues were examined by immunohistochemical localization to determine MMP-2 autocatalytic processing. Antibodies corresponding to both the catalytic domain and the hemopexin domain were utilized and tissues were observed under both ultraviolet and visible light microscopy. Images were merged to determine the extent of overlapping staining. While results regarding the proteolytic processing of MMP-2 were inconclusive, MMP-2 was expressed at extremely high levels in autoimmune thyroid tissue, indicating that MMP-2 may be responsible for much of the tissue damage and rearrangement observed in these tissues.

STUDIES ON THE ENDOCRINE DISRUPTING POTENTIALS OF FOOD COLORANTS. ***C. Sheng*, N. Smith, P. Datta, and S. Lundin-Schiller***, *Austin Peay State University, Clarksville, Tennessee*. The hypothesis that food additives erythrosin b (Eb; FD&C red 3) and tartrazine (Tz; FD&C yellow 5) are estrogenic was tested. Using *Molecular Operating Environment* (Chemical Computing Group v2006.08) software, Eb and Tz were analyzed for ability to interact with estrogen receptor (ER). Eb (Objective function value −11.1) and Tz (−9.3) display a high degree of molecular compatibility with ER active site as compared to endogenous ligand, estradiol-17β (E2) (−9.0). Cell proliferation studies using the T47D human breast cancer cell line showed E2 ($n = 9$), Eb ($n = 3$), and Tz ($n = 3$) significantly stimulated proliferation ($P < 0.001$) at all concentrations tested. Tamoxifen abrogated these effects. Vitellogenin (Vt) in whole body homogenates of zebra fish reared in water containing 0, 0.01, 0.1, and 1 nM E2, Eb, and Tz from day 1 to 40 (A) or day 20 to 40 (B2) was determined (Biosense, ELISA). Mean Vt for all negative controls was 0.99 μg/g fish. For A: 1 nM E2 group was lost. Significant Vt production over control occurred for 1 nM Eb (highest response: 1.2 mg/g fish). For B: significant stimulation of Vt occurred for 1 nM E2 (highest response: 1.2 mg/g fish).

THE EFFECT OF ESTRADIOL-17β, PROGESTERONE, AND FORSKOLIN ON EXPRESSION OF OXYTOCIN RECEPTOR MRNA. ***Ed Hadley* and Sarah Lundin-Schiller***, *Austin Peay State University, Clarksville, Tennessee*. The objectives were to establish methods for RT-qPCR for oxytocin receptor (OXTR) mRNA and to determine if estradiol-17β (E2) affects OXTR mRNA expression in human cell lines, T47D and WISH. Primer concentrations were optimized, efficiency of gene amplification was tested, and a relative standard curve was prepared using pooled RNA from T47D cells. Cells were grown in 50 mm plates to 80% confluence and treated for 24 h with either control (no treatment) or 1 nM E2. Total RNA was extracted and reverse transcribed. cDNA was amplified using SYBR green fluorescence in a ABI 7500 Real-Time PCR system. OXTR RT-qPCR results were normalized by endogenous control. Average relative fold induction of OXTR by E2 was 1.07 compared to control

indicating E2 had no significant effect on OXTR mRNA expression. WISH cells treated with 1 nM E2 similarly showed no significant change in OXTR mRNA levels. Preliminary results for other hormonal treatments in WISH [10 nM progesterone (P); 10 nM P for 24 h followed by 1 nM E2 for 24 h; or 50 uM forskolin] indicate little effect on OXTR mRNA synthesis.

PROPOSED *CAENORHABDITIS ELEGANS* DEFENSE PATHWAY AGAINST *STREPTOCOCCUS PNEUMONIAE*. ***Stephen May* and Nick Ragsdale***, *Belmont University, Nashville, Tennessee.* *Streptococcus pneumoniae* is the leading pathogen among bacteria that have a vaccine for treatment. The virulence factors for *Streptococcus pneumoniae* allow it to infect humans. Several organisms respond to these virulence factors by inducing programmed cell death (PCD). A *Caenorhabditis elegans* model explored PCD as a possible defense mechanism. Additionally, this model was utilized to investigate the possible connection between the p-38 MAPK signaling pathway and PCD. Programmed Cell Death provided protection against *S. pneumoniae* infection and evidence suggested a link between the signaling and cell death pathways.

CONFIRMING CHARACTERISTICS OF ENVIRONMENTALLY INDUCED PARKINSON'S DISEASE IN *CAENORHABDITIS ELEGANS*. ***Chelsea Wilson* and Nick Ragsdale***, *Belmont University, Nashville, Tennessee.* Parkinson's disease (PD) is a neurodegenerative disease characterized by dopamine neuron degeneration in the substantia nigra of the brain. While environmental toxin exposure, increased generation of reactive oxygen species, and inhibition of mitochondrial electron transport is the current hypothesis, the mechanisms of dopamine neuron degeneration and increase in the production of reactive oxygen species in PD is unknown. *Caenorhabditis elegans* serves as a good model system for the degeneration of dopaminergic neurons because of high conservation between nematodes and vertebrates. The effects of 6-hydroxydopamine (6-OHDA) on treated and control *C. elegans* have been characterized regarding egg laying, mean velocity, and centroid velocity. This research is interested in blocking the effects of 6-OHDA in adult *C. elegans* and confirming the role of 6-OHDA in producing PD-like disease. This information would support the previously characterized effects of environmentally induced PD in *C. elegans* and contribute to therapy for PD patients.

EFFECT OF 6-HYDROXYDOPAMINE TREATMENT ON ά-SYNUCLEIN AND PARKIN PROTEIN LEVELS. ***Jennifer Rix* and Nick Ragsdale***, *Belmont University, Nashville, Tennessee.* Previous studies have shown there are increases in both ά-synuclein and parkin protein levels in patients with neurodegenerative diseases such as Parkinson's Disease. These proteins are often found in clumps of proteins referred to as Lewey Bodies. Additionally, over-expression of ά-synuclein via microinjection techniques results in motor deficits. This study investigates the impact of the neurotoxin 6 hydroxydopamine on the expression of ά-synuclein and parkin proteins. It is expected these proteins will increase. These results will give insight into the potential role of environmental toxins in causing neurodegenerative diseases.

STUDYING THE INTERACTIONS OF TWO VARIOLA VIRUS PROCESSIVITY FACTORS. ***Sarah Brandt* and Debasish Chattopadhyay***, *Belmont University, Nashville, Tennessee, and University of Alabama, Birmingham, Alabama.* Smallpox may still pose a deadly threat to people throughout the world due to possible bioterrorist attacks. It is important that the virus is understood and investigated. Variola virus responsible for smallpox uses processivity factors to tether DNA polymerases to the DNA template so that replication is continuous. Processivity factors, therefore, can serve as good drug targets for possible cures to viral infections because of their lack of homology to eukaryotic cellular proteins and their requirement for replication to occur in the host organism. The proteins A20 and Uracil-DNA Glycosylase (UDG), two essential proteins that help to form the processivity factor in the smallpox virus, were examined. We expressed and purified A20, formed and purified the A20:UDG complex, and tested twelve antibodies in the hopes of finding one that disrupts the processivity complex. It was seen that all the antibodies disrupted the complex to some extent.

T-CELL CYTOKINES ASSOCIATED WITH INFLAMMATORY BOWEL DISEASE IN *MDRLA-/-* MODELS. ***Dale. S. Carter*, Jennifer. T. Thomas, Julia. M. Schmitz, Vance. J. McCraken, Reed. A. Dimmitt, and Robin. G. Lorenz***, *Belmont University, Nashville, Tennessee (DSC, JTT) and University of Alabama, Birmingham, Birmingham, Alabama (JMS, VJM, RAD, RGL).* Chemotherapy resistance has become one of the most serious difficulties associated with cancer treatment. The MDR (multidrug resistant) gene, which encodes for p-glycoprotein, has been shown to cause this resistance. To determine the biological function of p-glycoprotein, a knockout mouse was created. The loss of p-glycoprotein resulted in Inflammatory Bowel Disease (IBD). To study p-glycoprotein's function on different cell types, bone marrow chimeras were produced. In order to determine what CD4+T-Cell types are causing this colitis, I extracted RNA from colon samples of wild type, *mdr1a-/-*, and the two bone marrow chimeras, transcribed them into cDNA, and then performed Real-Time reverse transcriptase PCR to detect the specific cytokines of the different T-Cell types including Th1, Treg, and Th17 cells. In all the diseased animal models, the Th17 cytokines were detected in vastly higher amounts, indicating that the Th17 cell may play a more important role in causing IBD.

OCCURRENCE OF METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* IN BELMONT UNIVERSITY ATHLETICS FACILITIES. ***Brittany Myers* and Jennifer T. Thomas***, *Belmont University, Nashville, Tennessee.* *Staphylococcus aureus* is a gram positive, cocci-shaped bacterium. It can be carried on the skin or in the nose of healthy people and does not typically cause harm. In recent years, however, some types of this organism have gained resistance to antibiotics such as methicillin, creating methicillin-resistant *S. aureus* (MRSA). This "superbug" has recently found a home in schools around the country (including middle Tennessee), especially around athletics facilities and equipment. Given this increasing concern for MRSA, I chose to examine the athletic facilities at Belmont University to determine the occurrence of *S. aureus* isolates. Preliminary data indicate that *S. aureus* is extremely common accounting for greater than 50% of the bacterial isolates in two of the locations; all locations indicate *S. aureus* contamination. Studies to identify the presence of the *mecA* gene are in progress to determine the incidence of methicillin resistance gene in these isolates.

CHEMISTRY SECTION

MARTIN V. STEWART, CHAIR

A COMPUTATIONAL LOOK AT THE STRUCTURES OF SEVERAL ORGANOSILYLMAGNESIUM HALIDE ADDUCTS. ***William. H. Ilsley***, *Middle Tennessee State University, Murfreesboro, Tennessee.* The Hartree-Fock/6-31G** structures of several organosilylmagnesium halide adducts of the general formula $Y_3SiMgX{\bullet}nL$ (n = 1,2; Y = Me, SiH_3, $SiMe_3$, $Si(SiMe_3)_3$; X = F, Cl; L-THF, TMEDA, dioxane, pyridine, DME) will be discussed. The results show that the fluoro adducts exhibit a highly distorted tetrahedral geometry about magnesium, with average Mg-F distances of 1.790, 1.183, 1.800, and 1.792 Å, Mg-Si distances of 2.673, 2.667, 2.687, and 2.663 Å, and M-X distances of 2.184, 2.157, 2.687, and 2.176 Å, for the THF, TMEDA, dioxane, DME, and pyridine adducts, respectively. The average Si-Mg-F angles are 136.51, 134.61, 128.64, and 130.05°, respectively. The X-Mg-X angle is a function of the bite-angle of the ligand and varies from 74.13° to 104.80° in the adducts.

NEW THIOSEMICARBAZONES FOR ENVIRONMENTAL, MEDICINAL, AND ANALYTICAL RESEARCH. ***Edward C. Lisic***, *Tennessee Technological University, Cookeville, Tennessee.* Directed synthesis efforts for undergraduate research can be problematic for the research advisor due to many logistical difficulties. This presentation features an individual approach to undergraduate research within a teamwork setting that helps to solve many of these inherent difficulties by utilizing the directed synthesis of thiosemicarbazone compounds by undergraduate researchers. These studies have led us into new areas of research, which will be presented: new thiosemicarbazone compounds and ligands that have environmental, medicinal, and analytical applications.

C2 SUBSTITUTED IMIDAZOLIUM SALTS: THE ALKYLATION APPROACH. ***Elliot G. Ennis* and Scott T. Handy***, *Middle Tennessee State University, Murfreesboro, Tennessee.* The imidazolium cation has been the focus of much attention in recent years, most notably as a source of *N*-heterocyclic carbenes, which can be used either as ligands for transition metal catalysts or as catalysts themselves, and as the cationic component of the most popular family of room temperature ionic liquids. Particularly in this later role, the relative acidity of the C2 position of the imidazolium cation can be either advantageous or disadvantageous depending upon the circumstances. In an effort to prepare new room temperature ionic liquids that will avoid any acid/base chemistry at the C2 position, we have explored the direct alkylation of the C2 position of unsubstituted imidazolium cations as a versatile and concise route to substituted compounds. Details regarding the preparation, properties (melting points and viscosity), and potential applications of these materials will be presented.

OXYGEN IN GRAPHITE OXIDE STRUCTURES. ***JoAnn Scales*, Senthil N. Sambandam, Tocarra Cecil, and Weijie Lu***, *Fisk University, Nashville, Tennessee.* Graphene is a two-dimensional (2-D) honeycomb carbon lattice viewed either as a single layer of graphite or an unrolled nanotube. Graphenes exhibit similar physical properties with carbon nanotubes with promising electronic and photonic applications and the advantages of lower cost and higher purity than carbon nanotubes. A common technique to prepare graphene is to oxidize graphite through formation of graphite oxide. Graphite oxides (graphene oxide sheets) are heavily oxygenated with hydroxyl and epoxide functional groups on their basal planes, in addition to carbonyl and carboxyl groups located at the sheet edges. Interactions between oxygen and carbon atoms in graphite oxides were investigated by X-ray photoelectron spectroscopy and Raman spectroscopy. Oxygen interacting with graphitic basal planes also creates oxygen-contained defects on the planes, and the solution shows a very similar spectrum of carbon nanotube from ultraviolet to near infrared regions. A structural model is suggested.

POTENTIAL USE OF LIQUID CHROMATOGRAPHY/MASS SPECTROMETRY/MASS SPECTROMETRY OR GAS CHROMATOGRAPHY/MASS SPECTROMETRY IN IMMEDIATE WARRANT ISSUANCE OF A SUSPECTED CLANDESTINE METHAMPHETAMINE LABORATORY. ***Jeffrey O. Boles***, *Tennessee Technological University, Cookeville, Tennessee.* Warrant issuance is often a legal problem that results either in dropped charges due to illegal search and seizure or a delay resulting in lost opportunities for arrest and conviction. A desire exists for the development of improved detection strategies external to suspected clandestine laboratories that is admissible in a court of law. Liquid Chromatography/mass spectrometry (LC/MS), an up and coming technique for forensics, has been making steady inroads into laboratories over the past decade. Adoption of LC/MS has taken much longer in forensics due to cost. Thus, the legal system has been slow to accept these methods as admissible. Our ultimate goal is to develop a rapid protocol which involves the collection of samples external to the suspected clandestine laboratory, determination of methamphetamine in those samples, followed by data input and analysis in a GIS-system generating a methamphetamine map, not unlike that seen as a thunderstorm on the evening news. Preliminary data in this endeavor will be presented and discussed.

CHARACTERIZATION OF ANHYDROUS OLIGONUCLEOTIDES ON THE BASIS OF STRUCTURE BY ION MOBILITY-MASS SPECTROMETRY. ***Ablatt Mahsut*, Sophie R. Zhao*, and John A. McLean***, *Vanderbilt University, Nashville, Tennessee.* Mass spectrometry (MS) based characterization of complex biological samples typically requires that the sample complexity be reduced by using additional separation, such as liquid chromatography, prior to MS analysis. However, sample throughput is typically limited by the additional separation dimension chosen (min-h for LC-MS). Here we describe rapid (μsec-msec) 2D gas-phase separations using ion mobility-MS (IM-MS), which provides analyte separations on the basis of analyte surface area and mass-to-charge ratio (m/z), respectively. Empirically, different molecular classes adopt structures (surface areas) at a given m/z in the order lipids > peptides > carbohydrates/oligonucleotides. However, while more is known of lipid, peptide, and carbohydrate anhydrous structures, comparatively little is known of the gas-phase structures of oligonucleotides. In an effort to characterize oligonucleotides, we have analyzed a suite of standards up to 9-mers to begin characterizing the diversity of structures that oligonucleotides adopt in IM-MS measurements.

DEVELOPMENT OF SURFACE-ENHANCED RAMAN SCATTERING METHODS FOR THE ANALYSIS OF ACTIVE PHARMACEUTICAL INGREDIENTS. ***Subathra Ramamoorthy*, Beng G. Ooi, and Ngee-Sing Chong***, *Middle Tennessee State University*. Raman spectroscopy has applications in a wide spectrum of areas including forensic, environmental, chemical, and pharmaceutical industries. We are exploring the possibility of using surface-enhanced Raman scattering (SERS) technique in analyzing active pharmaceutical ingredients. Existing methods based on chromatography and UV-vis spectroscopy have one or more of the following drawbacks such as the lack of specificity, laborious sample preparation, lengthy analysis, need for solvent extraction, and the requirement for highly skilled operators. Raman spectroscopy enables rapid and non-destructive analysis with minimal sample preparation. However, Raman signals are usually weak and may not be practical for pharmaceutical formulations. Therefore, SERS techniques based on gold or silver colloid are used to enhance the Raman signal by up to one million times. The goal of this project is to use SERS as a detection tool for analyzing analgesics and antibiotics separated by techniques such as thin layer chromatography, liquid chromatography, or capillary electrophoresis.

A HISTORY OF THE CHEMISTRY SECTION OF THE TENNESSEE ACADEMY OF SCIENCE, 1940–2007. ***Martin V. Stewart and James X. Corgan***, *Middle Tennessee State University, Murfreesboro, Tennessee and Austin Peay State University, Clarksville, Tennessee*. Chemists heard 632 papers since founding the Chemistry Section in 1940. There are two distinct phases in the history of oral presentations to the Section. In Phase I (1940–1967), typical meetings involved six or seven talks. Phase II began in 1968 and is on-going. Members now hear about 11 papers per meeting. A total of 239 talks were given at annual meetings from 1986 to 2007, 84% of which were contributed by Middle Tennessee State University (41%), Tennessee Technological University (19%), Vanderbilt University (13%), and Austin Peay State University (11%). Poster presentations officially began in 1995. They emphasize undergraduate research and often outnumber the talks. Since 1940, the Chemistry Section contributed 10 presidents to the Academy: Hanor A. Webb (1946), Frances R. Bottum (1949), Carl T. Bahner (1951), Christopher P. Keim (1959), Norman Campbell (1967), Richard Raridon (1970), Albert L. Myers (1975), Eugene A. Kline (1998), David J. Wilson (2000), and Martin V. Stewart (2001). Keim and Raridon also were active physicists.

THE POLYCOUPLING APPROACH TO SUBSTITUTED THIOPHENES. ***Samantha T. Varallo* and Scott T. Handy***, *Middle Tennessee State University, Murfreesboro, Tennessee*. As part of a larger research project directed at the development of the polycoupling approach to polysubstituted heteroaromatics, we have studied the regioselective Suzuki couplings of 2,3- or 2,4-dibromothiophene. Substituted thiophenes have a number of potentially interesting applications, including as therapeutic agents (anti-tubulin or COX-II inhibition), as organic conducting materials, or as sensors. Beyond determining that good regioselectivity can be obtained for the first coupling, we also have developed conditions that enable a one-pot double Suzuki coupling. One of the key factors is in performing a modest degassing of the reaction mixture by bubbling argon through it for 10 min prior to addition of the palladium catalyst. This degassing helps to keep the catalyst stable enough to also work for the second coupling. Otherwise, it precipitates out of solution as the first coupling nears completion and is not active for the second coupling.

THE POLYCOUPLING APPROACH TO SUBSTITUTED THIOPHENE ALDEHYDES. ***Diyar M. Mayi* and Scott T. Handy***, *Middle Tennessee State University, Murfreesboro, Tennessee*. As part of a larger research project directed at the development of the polycoupling approach to polysubstituted heteroaromatics, we have studied the regioselective Suzuki coupling of 4,5-dibromothiophene-2-carboxaldehyde. Substituted thiophenes have a number of potentially interesting applications, including as therapeutic agents (anti-tubulin or COX-II inhibition), as organic conducting materials, or as sensors. Beyond determining that good regioselectivity can be obtained for the first coupling, we also have developed conditions that enable a one-pot double Suzuki coupling. One of the key factors is in using minimal amounts of water to avoid significant amounts of dehalogenation during the first coupling, but to also have some water available in order for the couplings to occur at all.

THE POLYCOUPLING APPROACH TO SUBSTITUTED FURANS AND PYRIMIDINES. ***Samantha C. Chesak* and Scott T. Handy***, *Middle Tennessee State University, Murfreesboro, Tennessee*. As part of a larger research project directed at the development of the polycoupling approach to polysubstituted heteroaromatics, we have studied the regioselective Suzuki couplings of 4,5-dibromofurfural and 2,4-dichloropyrimidine. Both of these families of compounds have a number of potentially interesting applications, including as therapeutic agents or sensors. Good regioselectivity can be achieved in the first coupling with either of these compounds. Unfortunately, for the furfural series, the products cannot be readily separated from the starting material and other by-products, thereby rendering this reaction of limited utility. For the pyrimidines, very good yields of the first coupling can be readily achieved. The second coupling is much more difficult and so far has only afforded very modest yields of the decoupled product. More active catalysts are currently being studied and are expected to afford improved results.

THE POLYCOUPLING APPROACH TO SUBSTITUTED THIAZOLES. ***Tyler Walker* and Scott T. Handy***, *Middle Tennessee State University, Murfreesboro, Tennessee*. As part of a larger research project directed at the development of the polycoupling approach to polysubstituted heteroaromatics, we have studied the regioselective Suzuki coupling of 2,4- or 2,5-dibromothiazoles. Substituted thiophenes have a number of potentially interesting applications, including as therapeutic agents (antibiotic or COX-II inhibition). Regioselectivity in the first coupling is very high for the C2 position and occurs in generally good yield. Unfortunately, attempts to perform a second coupling in the same reaction pot using the same catalyst have failed entirely due to catalyst precipitation. No modifications of the reaction conditions have enabled us to avoid this problem. A tentative solution is to filter the reaction after the first coupling and then add fresh catalyst, base, and the second boronic acid and run the second reaction. In this way, decoupled products have been obtained in generally decent yield.

THE SYNTHESIS OF FLUORINE-CONTAINING CHALCONES. ***Aileen J. Guerrero* and Daniel J. Swartling***, *Tennessee*

Technological University, Cookeville, Tennessee. Acetophenone was reacted with fluorine-containing benzaldehydes to produce fluorine-containing chalcones in 85% to 95% yield. The compounds were characterized by NMR and their physical properties measured. The fluorine-containing chalcones will be used to make nitromethyl-containing diaryketones via Michael addition with nitromethane.

ELECTRON MICROSCOPY OF THE Ce(IV)/SiO_2 SOLID-SUPPORTED REAGENT. ***Kristy J. Stanislav*, Anthony L. Newsome, Marion R. Wells, and Martin V. Stewart,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Optical micrographs (both brightfield and darkfield) were obtained for the Ce(IV)/SiO_2 solid-supported reagent, prepared by adsorbing ceric ammonium nitrate (CAN) onto silica gel. Heterogeneous mixtures of three types of coated particles (clear and colorless, translucent, and opaque) result for weight ratios of CAN to silica gel at 20:100 or above. It was observed that crystals of CAN form when the surface of some particles of silica gel become saturated beyond monolayer coverage of the inorganic reagent, and these continue to grow until the solid support is wholly encased. We now report the first images obtained for these samples with a Hitachi S-3400N scanning electron microscope (SEM) and will describe details of their surface morphology not clearly resolved with optical microscopy even at a magnification of 1000 times. (Supported by Undergraduate Research Council, College of Basic and Applied Sciences, Middle Tennessee State University)

THE KNOVENAEGEL REACTIONS OF MELDRUM'S ACID WITH ALDEHYDES AND KETONES. ***Daniel J. Roubik* and Daniel J. Swartling,*** *Tennessee Technological University, Cookeville, Tennessee.* Meldrum's Acid was reacted with substituted benzaldehydes and cyclohexanone to produce cyclohexylidene and arylidene adducts in 55% to 85% yield. The compounds were characterized by NMR and their physical properties measured. The Knoevenagle adducts will be used to make nitromethyl-containing compounds via Michael addition with nitromethane.

AN INVESTIGATION OF THE PYRIDOXAL-5′-PHOSPHATE-β-CHLORO-ALANINE REACTION BY LIQUID CHROMATOGRAPHY/MASS SPECTROMETRY/MASS SPECTROMETRY. ***Taylor J. King* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* Tryptophan Synthase (TS) is a bi-functional, tetrameric, and pyridoxal-5′-phosphate (PLP) dependant enzyme that catalyzes the last two steps in the biosynthesis of L-tryptophan. Tryptophan synthase is one of many enzymes now broadly used in synthetic organic and biochemical studies and has received greater attention in the last decade. We recently identified a problem with the TS spectrophotometric assay utilized in enzyme kinetic studies when β-chloro-alanine (BCA) is utilized in place of L-serine as substrate. The nature of this problem is in the formation of a side product that forms between PLP and BCA even in the absence of enzyme. The formation of L-tryptophan by TS is monitored as an increase in absorbance at 290 nm. The side product also absorbs light at this wavelength which results in an additive effect in kinetic assays. The products of the BCA-PLP reaction characterized by LC/MS/MS will be presented.

SYNTHESIS OF CYCLOPROPYL AND TETRAZOLE PEPTIDOMIMETICS OF D-ALA-D-ALA. ***Edward K. Hawkins*, Phillip L. Singer*, and Norma K. Dunlap,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The β-lactam family of antibacterial agents act by inhibition of D-D-peptidase enzymes, which catalyze formation of cross-links in the bacterial cell wall. The enzymes catalyze cleavage of the terminal D-ala-D-ala unit of a peptidoglycan strand. A series of peptidomimetics of the enzyme substrate D-alanyl-D-alanine have been designed as potential antibacterial agents. The analogs contain a hydroxyethylene isostere as a replacement for the amide bond. A protected form of the target molecule has been synthesized, and progress has been made on the preparation of a tetrazole analog of the peptidomimetic. A rigid analog containing a cyclopropyl ring also has been synthesized. Both the linear tetrazole and cyclopropyl analogs proceed through a common synthetic strategy starting with D-alanine. Optimization of the cyclopropyl synthesis involves a Corey-ylide cyclopropanation, while synthesis of the tetrazole proceeds through a nitrile analog of the peptidomimetic.

ELECTRONIC STRUCTURE AND OXIDATION OF MANGANESE DIMERS $[Mn(SALPN)(OCH_3)]_2$ AND $[Mn_2(SALPN)_3]$. ***Mary C. Clay* and Rebecca M. Jones,*** *Austin Peay State University, Clarksville, Tennessee.* Previous studies of the oxygen evolving complex (OEC) in photosystem two (PS II) led to the synthesis of several different manganese complexes with the Schiff-base *N,N′*-bis(salicylidene)propane-1,3-diamine (H_2SALPN) ligand in an effort to model the OEC. This study focuses on characterization of the electronic structure and reactivity of the air sensitive manganese (II) Schiff-base dimer complexes $[Mn^{(II)}(SALPN)(OCH_3)]_2$ and $[Mn^{(II)}{}_2(SALPN)_3]$. The metal ligand vibrations have been characterized by infrared spectral analysis of both the normal isotope and ^{15}N-labeled H_2SALPN ligand. UV-vis spectral analysis of the complexes before and after oxidation has confirmed that the complexes are the manganese (II) equivalents of the reported manganese (III) complexes based on the low molar absorptivities of Mn^{2+} complexes in comparison to Mn^{3+}. Future study of the complexes will include kinetic studies of the synthesis and oxygen reactivity of the complexes and the determination of redox potentials via cyclic voltametry.

SYNTHESIS AND CHARACTERIZATION OF NEW CHROMONE THIOSEMICARBAZONE COMPOUNDS. ***Erica Stoner* and Edward C. Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* Thiosemicarbazone compounds are potent biological agents, and also act as ligands to a whole host of transition metal ions. A series of eight new thiosemicarbazones and semicarbazone compounds synthesized from a formyl chromone backbone in our laboratory will be discussed. The synthesis of this new series of compounds is straightforward, and characterization by ^{1}H NMR and IR that supports the proposed structures also will be presented.

COULOMBIC MODEL OF THE ANOMALOUS CONFORMATIONS OF THE CHLORINATED ACETATES. ***Taylor A. Barnes* and Preston J. MacDougall,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Quantum chemical calculations and crystallography data indicate that the chlorinated acetates favor several counterintuitive conformations in which a chlorine atom is eclipsed with a carboxyl oxygen. In order to explain these results, the Quantum Theory of Atoms in Molecules is used to examine the conformational behavior of

the chloroacetate anion at the atomic level. Trends in atomic energies, dipoles, and electron densities are presented. The anomalous conformational energies are modeled in terms of a novel perspective on intramolecular Coulombic interactions, and the stability of the eclipsed conformation is attributed to a chlorine-induced dipole along the carbon-carbon bond that lowers the energy of both eclipsed atoms.

CHEMICAL PROFILING CLANDESTINE METHAMPHETAMINE. ***Sri Bharat Madireddy* and Jeffrey O. Boles***, *Tennessee Technological University, Cookeville, Tennessee.* Over the years Methamphetamine (*N*-methyl-1-phenylpropan-2-amine), a potent psycho-stimulant, has been a major cause of concern throughout the world, especially in the State of Tennessee. Illicit manufacture of methamphetamine in clandestine laboratories has been carried-out with the use of minimal over-the-counter ingredients. To positively identify the cook of this drug, a signature profile of the seized methamphetamine is necessary. The first choice of tools in designing a "chemical profile" or "chemical fingerprint" for these clandestine drugs is gas chromatography/mass spectrometry (GC/MS). Little or minimal work has been carried out on seized samples of methamphetamine using liquid chromatography/MS (LC/MS). Liquid chromatography, in combination with MS/MS has advantages over GC, such as sensitivity. The present research will establish a database of impurities using both GC/MS and LC/MS by obtaining pure standards of common impurities found in seized Tennessee clandestine methamphetamine. We will compare seized samples with the database for positive identification of the types and quantities of impurities present, the method of synthesis, the proportions, source and purity of starting materials, the reaction conditions, and the purification procedures, if any.

METHODS DEVELOPMENT FOR THE DETERMINATION OF FLUORIDE IN ARCHAEOLOGICAL ANALYSIS OF FAUNAL REMAINS. ***Tu Vu*, Reubyn W. Chong*, Kemilah Banks-Word*, Ngee-Sing Chong, Judith Iriarte-Gross, and Kevin E. Smith***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Radiocarbon analysis is a well-known, reliable, but expensive method for dating prehistoric bone specimens. An alternative and more economical method for developing fine-scale relative dates is fluoride dating, which is based on the principle that buried bones incorporate fluoride ions from surrounding soils over time. Although widely used in many parts of the world, this method has not been tested for potential applications in the southeastern United States. Application of traditional techniques using fluoride ion selective electrode (FISE) on faunal samples from archaeological sites dating between AD 1200 and 1450 in Tennessee confirm the validity of this method in local soil conditions. Preliminary results of new techniques for fluoride analysis using X-ray fluorescence spectrometry (XRF) and scanning electron microscopy-energy dispersive X-ray analysis (SEM-EDX) also are examined.

EXPERIMENT VERSUS COMPUTATION: WHAT DOES NATURE THINK OF HUMAN-DESIGNED PROTEINS? ***Beth A. Repasky*, Brent M. Dorr*, Carie A. Fortenberry, Laura Mizoue, and Jens Meiler***, *Belmont University, Nashville, Tennessee (BAR) and Vanderbilt University, Nashville, Tennessee (BMD, CAF, LM, JM).* A statistical term that accounts for surface-residue solvation of de novo proteins has been created in a *de novo* protein design program, Rosetta. This is done by differentiating between surface, or polar, amino acids and core, hydrophobic amino acids. The new alteration in Rosetta Design is tested by creating a *de novo* four-fold symmetrical TIM barrel design, an alpha-beta barrel fold common in nature. Three rounds of design have led to an improvement of this algorithm through experimental expression and characterization of the designed proteins. A fourth round of design is currently being created to combine the best attributes of each of the previous results.

ORGANIC TEXTS: WHAT DO WE ACTUALLY COVER? ***Elliot G. Ennis*, Amy J. Phelps, and Michael J. Sanger***, *Middle Tennessee State University, Murfreesboro, Tennessee.* One purpose for textbooks is they are designed to compliment material covered in lecture, but given the rather encyclopedic nature of current textbooks, this begs the question, "What is being covered in lecture?" Using organic chemistry as the focus, this question was investigated by surveying organic chemistry professors to determine what concepts they covered in their organic chemistry courses. The Survey Monkey online survey program was used to construct a short 10-question survey that was sent to organic chemistry professors at various types of institutions across the nation. The results in terms of what professors feel is core material and what is extraneous will be presented as well as some concrete suggestions on things the professors wanted to see changed.

MUTATION OF YEAST CELLS TO PRODUCE A MITOCHONDRIAL-DEFICIENT STRAIN WITH HIGH TOLERANCE TO ETHANOL. ***Kevin R. Lankford* and Beng Guat Ooi***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Ethanol is a fuel additive that allows gasoline to burn cleaner in engines and is produced from the fermentation of sugar by yeast. To produce yeast strains that are tolerant to higher (>15%) ethanol levels, two mutation methods were used. The first method involved growing the cells in yeast complete media containing 25 μg/mL ethidium bromide. In the second method, cells were grown in nitrogen based media containing 15% ethanol. One set of mutants was further subjected to growth in media containing 500 μg/mL lycorine to select for mutants that are also rho^0 or lack mitochondria DNA. A total of fourteen mutants were isolated and tested for growth in media containing 15% ethanol. Nine of these mutants were lycorine resistant and possibly rho^0 mutants. Each yeast mutant was tested for its efficiency in converting sugar to ethanol so their potential for bioethanol production could be compared.

MERCURY EMISSION FROM TERRESTRIAL BACKGROUND SURFACES IN THE EASTERN UNITED STATES: AIR/SURFACE EXCHANGE OF MERCURY FROM AN OPEN FIELD SITE. ***Hong Zhang and Todd Kuiken****, *Tennessee Technological University, Cookeville, Tennessee.* Mercury air/surface exchange was measured in spring and summer of 2004 over an open field site on Tennessee Technological University campus to quantify Hg emission from an open field and compare to background forest sites. This study was focused on determining the factors controlling the Hg flux and the fate of atmospheric deposited Hg, to compare the results with the western enriched soils in relation to Hg emission patterns, trends, and factors, and to evaluate implications to scaling. Generally, the Hg air/surface exchange fluxes observed at the open field site

were extremely low (0.1 ± 0.6 ng m^{-2} h^{-1}) and no correlations of the fluxes were found to the environmental parameters measured. The data indicate similarities in the Hg emission between the open field site and the canopy covered forest systems. More extensive investigation of these surfaces is warranted to verify and understand this phenomenon.

ANALYSIS OF VOLATILE ORGANIC COMPOUNDS BY SORBENT TUBE AND INFRARED SPECTROSCOPIC TECHNIQUES. ***Craig Lampert and Ngee-Sing Chong***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Toxic compounds in air are frequently found at trace concentrations and, hence, their direct analysis can be challenging. Analyte preconcentration using sorbent tubes followed by a thermal desorption step to transfer the analytes into a long path length gas cell for infrared (IR) spectrometry is evaluated for its analytical performance in detecting trace pollutants. The analytical reliability was influenced by water vapor and carbon dioxide in air samples. Therefore, their background IR absorbances were reduced by scrubbing the samples with NaOH and molecular sieve materials, respectively. The concomitant preconcentration of analytes with the rejection of water vapor was achieved with hydrophobic sorbent materials such as Carboxen 1000, Carbopack X, Carbotrap, and Carbopack Y. By carefully avoiding analyte breakthrough, preconcentration factors of 20- to 500-fold were achieved for trace gas analysis. The optimal parameters of thermal desorption in terms of desorption temperature and flow rate of desorbing gas also were characterized.

DETERMINATION OF NUCLEAR MAGNETIC RESONANCE PARAMETERS NEEDED TO STUDY MICRORNA. ***Phillip Mnirajd*, James C. Howard, and Elliot Dawson***, *Middle Tennessee State University, Murfreesboro, Tennessee (PM, JCH) and BioVentures, Inc., Murfreesboro, Tennessee (ED).* A microRNA (miRNA) is a single-stranded RNA molecule of about 21–23 nucleotides in length. Some are known to regulate gene expression by binding to messenger RNA, and others contribute to cellular development and other biological functions. To determine the feasibility of using 500 MHz nuclear magnetic resonance (NMR) to study miRNA, P-31 and H-1 spectra were obtained for two different DNA doconucleotides (22 bases, ~5 mg in 0.5 mL D_2O). In one a sulfur replaced an oxygen in a phosphate group. H-1 spectra were obtained in five min with peaks in the 6–8 ppm region easily detected and resolved. P-31 spectra took over nine h with each having a single peak near 0 ppm. The sulfur-containing sample also had two peaks near 55 ppm which collapsed to a singlet upon elevating the temperature to 55°C. The results will be used to design NMR experiments on miRNA.

PROBING THE DNA-BINDING CAPABILITY OF 4-AMINOBIPHENYL AND ITS METABOLITES BY RAMAN SPECTROSCOPY. ***Etsubdenk M. Fikremariam* and Beng Guat Ooi***, *Middle Tennessee State University, Murfreesboro, Tennessee.* The DNA-binding capability of 4-aminobiphenyl, a carcinogen found in cigarette smoke, was evaluated using surface-enhanced Raman scattering (SERS). This technique is capable of producing vibrational spectra of carcinogens and biomolecules on substrate surfaces coated or impregnated with silver colloid. The tendency of carcinogens to form DNA adducts was evaluated by comparing calf thymus DNA spectra before and after treatment with the carcinogens. The SERS technique was able to significantly enhance the sensitivity for the detection of DNA adducts by virtue of the interactions between silver nanoparticles and DNA adducts. For nitrocellulose filter, Raman spectra based on the interaction of 50 μg of DNA and 5–12.5 μg of 4-aminobiphenyl have been obtained. Spectral characteristics and procedures based on different substrate materials such as copper, plastic cover slip, and nitrocellulose membrane have been investigated. Preliminary data show this approach may be suitable for studying DNA adduct formation.

SEPARATION OF THE MINOR ACTINIDE ELEMENTS FROM LANTHANIDE FISSION PRODUCTS USING SOFT DONORS. ***Matthew H. Zimmerman* and Dale D. Ensor***, *Tennessee Technological University, Cookeville, Tennessee.* The separation of minor actinides such as Am(III) from fission products, especially the +3 lanthanides, remains a difficult problem because of the similarities in the aqueous chemistry of these elements. This project seeks to improve the separation of these elements utilizing soft (N, S) donor groups in the extractant molecules that show a greater attraction for Am(III) when compared to the trivalent lanthanides. The extractant, bis(chlorophenyl)dithiophosphinic acid (BCTP) was used in combination with a synergist, 4,7-diphenyl-1,10-phenanthroline (DIPHEN) to extract Am(III) and Eu(III) from aqueous nitrate media. Separation factors (D_{Am}/D_{Eu}) of between 300 and 500 were obtained between 0.01–0.001 M HNO_3. The extraction efficiency of this synergistic mixture for Am(III) and Eu(III) was measured by varying the concentration of the extractant, synergist, and nitric acid at a total ionic strength of 0.50 M. A slope analysis technique was used to evaluate the extracted species. The results suggest this synergistic system may be useful for group separation of the minor actinides from the lanthanides.

NEW PALLADIUM COMPLEXES FOR ANTI-CANCER RESEARCH. ***Rachel C. Huxford* and Edward C. Lisic***, *Tennessee Technological University, Cookeville, Tennessee.* This work presents the synthesis and characterization of a new series of phenanthrenequinone thiosemicarbazone palladium complexes. One of these complexes, derived from phenanthrenequinone thiosemicarbazone, has previously been described in the literature. This complex displayed activity against MCF-7 human breast cancer cells, suggesting the other complexes are potential anti-cancer agents. The other complexes of this series are: phenanthrenequinone methylthiosemicarbazone, phenanthrenequinone ethylthiosemicarbazone, phenanthrenequinone phenylthiosemicarbazone, and phenanthrenequinone benzylthiosemicarbazone. Each tridentate thiosemicarbazone ligand (L), when reacted with K_2PdCl_4, produced a square planar palladium complex in the form Pd(L)Cl. The complexes were characterized via ^1H nuclear magnetic resonance spectrometry, infrared spectrometry, and UV-visible spectroscopy, and their magnetic susceptibilities were obtained. The crystal structure of the phenanthrenequinone benzythiosemicarbazone complex is also presented.

EXTRACTION OF CESIUM FROM ALKALINE MEDIA UTILIZING A FUNCTIONALIZED CALIX[4]ARENE-BENZOCROWN ETHER. ***John D. Partridge*, Dale D. Ensor, Laetitia H. Delmau, Bruce A. Moyer, Richard Bartsch, and Hui Zhou***, *Tennessee Technological University, Cookeville, Tennessee (JDP, DDE), Chemical Separations Group, Oak Ridge National*

Laboratory, Oak Ridge, Tennessee (LHD, BAM), and Texas Tech University, Lubbock, Texas (RB, HZ). Selective separation of cesium from other alkali metals under alkaline conditions is a challenging problem in nuclear waste processing. The discovery of calixarene-crown ethers provided a new class of cesium-selective extractants that have been shown to be the strongest and most selective extractants for cesium yet developed. This investigation describes the properties of lipophilic calix[4]arene-benzocrown-6 ethers in the 1,3-alternate conformation functionalized with acidic pendant group containing an anisole substituent (CAB6-anisole). The extraction of cesium from aqueous nitrate solutions into toluene solutions containing the CAB6-anisole was measured as a function of pH, extractant concentration, and nitrate concentration. These distribution values were mathematically modeled to determine the formation constants of the complexes formed in the organic phase. The resulting formation constants showed that attachment of the acid group to the calixarene-crown molecule reduced the binding stability for the cesium ion upon contact with an acidic solution. These results will be compared to previous work and the application of these compounds to cesium separation processes will be discussed.

HIGH-THROUGHPUT QUANTIFICATION OF PHOSPHORYLATED PEPTIDES USING CHEMICAL MODIFICATION AND ADVANCED STRUCTURAL MASS SPECTROMETRY. ***Randi L. Gant* and John A. McLean,*** *Vanderbilt University, Nashville, Tennessee.* Mass spectrometry (MS) based proteomics techniques are currently the dominant methods for post-translational modification identification and analysis. In spite of the many advantages associated with these methods, there are still significant challenges in separation, characterization, locating, and quantifying phosphorylated peptides and proteins. Several factors—heterogeneous phosphorylation, phosphoric acid loss due to beta-elimination, and varying extent of phosphorylation among different amino acids—result in sub-stoichiometric amounts available for analysis. Ion mobility-MS) is a high throughput separation method that has been shown to selectively separate peptides into correlation lines directly from complex biological samples based on ion structure. The aim of this work is to develop a protocol for tagging phosphorylated peptides with high density, low surface area tags that result in a mobility shift off of the anticipated peptide correlation line. Lanthanide chealates can then be used to allow for multiplexed tagging of multiple phosphopeptide samples.

ENGINEERING AND ENGINEERING TECHNOLOGY SECTION

ADEL SALAMA, CHAIR

EVALUATION OF PHASE CHANGE MATERIALS FOR ENERGY CONSERVATION. ***David W. Yarbrough, Jan Kosny, and R. J. Alderman,*** *R &D Services, Inc., Cookeville, Tennessee, The Oak Ridge National Laboratory, Oak Ridge, Tennessee, and Alderman Research Ltd., Wilmington, Delaware.* Careful positioning of organic or inorganic phase change material (PCM) in a building envelope can result in significant reduction in cooling and heating loads. The PCM and location must be selected so that temperature at the selected position cycles through the phase-change temperature. The PCM alternately absorbs heat (charges) and releases heat (discharges) in response to changing ambient temperature. The result is a net reduction in the heat gain or heat loss from the conditioned space due to the interception of heat by the PCM and alteration of the temperature profile in the building envelope. Laboratory scale measurements show 40–60% reduction in heat gain or heat loss by the constant temperature region. Similar results have been obtained with full-size building elements exposed to the ambient on one side. An observed shift in the peak-load benefits utility companies. The peak-load shift will benefit consumers when the cost of utilities is linked to time of use. Both distributed and localized PCM provide reductions in utility use in climates with significant diurnal temperature swings.

A HISTORY OF THE ENGINEERING SECTION OF THE TENNESSEE ACADEMY OF SCIENCE 1955–2006. ***David W. Yarbrough and James X. Corgan,*** *Tennessee Technological University (retired), Clarksville, Tennessee, and Austin Peay State University (retired), Clarksville, Tennessee.* An analysis of activity in the Engineering Section of the Tennessee Academy of Science completed in 1987 for the period 1955–1986 observed that participation in the Section had been erratic. The Section did not meet for 13 of the annual meetings during the period. Active Section meetings contained between 2 and 14 papers. The period from 1987 to 2006 has been more consistent than the earlier period due perhaps to the increased emphasis on research in Tennessee's Engineering Colleges. The performance of the Engineering Section during the later period will be discussed and combined with the 1955–1986 report to provide a view of the Engineering Section for the period 1955–2006.

SMOOTH MUSCLE CELLS SIGNALING MODEL OF DYNAMIC CEREBROVASCULAR REGULATION. ***Nithya Narayanan* and Michael. L. Daley,*** *University of Memphis, Memphis, Tennessee.* Cerebrovascular regulation (CA) refers to the ability to maintain constant cerebral blood flow despite changes in the pressure across the brain. Mechanisms underlying both the transient phase of CA (dynamic cerebrovascular regulation, DCA) and the steady state phase of CA (static cerebrovascular regulation, SCA) are poorly understood. To develop a model of electrical signaling mechanism between smooth muscle cells (SMC's) underlying DCA, six preparations with demonstrated intact CA and six with demonstrated impaired CA were modeled. Results indicated the direction of propagation of the electrical signal was from the distal segment of the vasculature to the proximal segment for six preparations that demonstrated intact CA and vice versa for the six preparations that demonstrated impaired CA. In conclusion the proposed signaling model consistently accounted for the mechanism underlying DCA and the direction of propagation for both intact and impaired cerebrovascular regulation.

MATHEMATICAL ANALYSIS OF SUNSPOT DYNAMICS. ***Lisa A Rightmire* and Michael L. Daley,*** *University of Memphis, Memphis, Tennessee.* Sunspot activity is a cyclic process with an average period of 11 years. Solar activity has been related to changes in earth's weather, satellite function, and electrical power distribution. Therefore, methods to predict the characteristics of future solar cycles are needed. Recently two methods of predicting the magnitude of sunspot activity in the next cycle were proposed. One method is based on precursors related to the

relaxation phase of the immediate cycle, while the other method is based on precursors derived from long-term trends. Our analysis of sunspot numbers over the past 250 years has revealed that a long-term cyclic process with an average period of 86 years may exist. The aim of this study is to develop dynamical mathematical models of both the 11-year and long-term cyclic sunspot processes that can be used to predict the immediate solar cycle.

A FINITE ELEMENT ANALYSIS STUDY OF THE INFLUENCE OF THE ELASTIC MODULUS OF THE NUCLEUS PULPOSUS ON THE BIOMECHANICAL PERFORMANCE OF A MODEL OF A CERVICAL SPINE MOTION SEGMENT. ***Yuan Li* and Gladius Lewis***, *University of Memphis, Memphis, Tennessee.* A three-dimensional geometrically-accurate solid model of a section of the human cervical spine (C4–C6) was constructed by using computed tomography scans of the vertebrae and patched NURBS (Non-Uniform Rational B-Spine) surfaced between each vertebra for the intervertebral discs (IVDs). The model was subjected to a compressive force of 250 N (uniformly distributed on its most proximal surface) and fully constrained at its distal end, and was validated by comparing the longitudinal displacement (Δ), obtained using the finite element analysis method, with literature Δ results. An increase of the modulus of elasticity of the nucleus pulposus of the C5–C6 IVD from 0.18 to 9.4 MPa led to significant increases of Δ, von Mises stress, and strain energy density for the model. The significance of the results is discussed vis a vis the design of a synthetic nucleus pulposus replacement.

MAINTANING LONG-TERM CELL VIABILITY IN A PERFUSED BIOREACTOR SYSTEM. ***Jenny Q. Lu*, Dmitry A. Markov, and Lisa J. McCawley***, *Vanderbilt University, Nashville, Tennessee.* Fabrication of a small scale bioreactor system with improved delivery of drugs or assay reagents can be highly beneficial to the development of an anti-tumor therapy, and key cellular functional signatures will be identified to predict the response to anti-tumor therapy. Experiments show that 5000 cells/chamber of human mammary epithelial cell lines (MCF10A) in chamber slide is optimal for the 3D formation of acini morphology or mammosphere during 20 days, and that correlates to 2000 cells/well in the parallel channel bioreactor. After comparing the gene expression profiles from Microarray Data Set, only a few protease family classes are differentially expressed by four cell lines. Effects of individual inhibitors and protease cocktails are compared. Calcein AM (1 μM) and Ethidium Bromide (2 μM) are the optimal concentrations for the live-dead viability assay. The new and improved parallel channel bioreactor design is a high thru-put device that allows optical capabilities.

MODIFYING TRACKING IN THE MAGNETIC TWEEZER SYSTEM. ***Elly N. Sinkala*, Jill C. Mecklenborg, Franz J. Baudenbaucher, and John P. Wikswo***, *Vanderbilt University, Nashville, Tennessee.* Viscoelasticity is determined by lipid-protein bilayer, microfilaments, and other structural components. Evaluating viscoelasticity provides insight into the cell's internal structure, especially under the influence of cancer or drugs. In epithelial cells, E-cadherin plays an important role in cell-cell adhesion. Previous research shows that E-cadherin disregulation is a significant component in invasive cancers. To understand this effect, Fc-E-cadherin coated beads and the magnetic tweezers system are used to measure the force between Madin-Darby Canine Kidneys cells and the beads. Velocity and position are the primary measurements to verify the tracking system and measure the force exhibited on the bead. It is important to have a tracking system that can accurately measure the velocity and force of cell-cell adhesion. To improve the tracking system, the program Slidebook and fluorescent beads were implemented. The beads provided better image contrast, but Slidebook did not accurately track the beads. A user-created tracking system was implemented.

GALVANOTACTIC CELL CONTROL IN A MICROFLUIDIC TITLE. ***Arunan Skandarajah*, Devin B. Henson*, Eric Z. DeLong*, and John Wikswo***, *Vanderbilt University, Nashville, Tennessee.* Cellular response to electric fields is a physiologically important field that has been under-explored because of deficiencies in the current devices available. We are seeking to develop a device on the microfluidic scale that will address problems with the current and promise a platform for rapid production of experiment-specific devices. We have followed the design process through several iterations, and through continuous modification we have translated our concept to a functional prototype electrical gradient generator. Characterization of this device has included determining the electrical potential profile across the experimental area for a given applied voltage and the detection of possible pH gradients. Our current task is the validation of this device with respect to published literature on the migration rates at particular voltages of *Dictyostelium discoideum*, a ubiquitous model for amoeboid crawling movement.

CYTOKINETIC QUANTIFICATION FOR CELL CONDITIONS ASSAY AND BEHAVIORAL DYNAMICS IN A MICROFLUIDIC DEVICE. ***Eric G. R. Kim*, John P. Wikswo, and Kevin T. Seale***, *Vanderbilt University, Nashville, Tennessee.* Cellular motion (cytokinetics) is one of many observable qualities of a cell that may be used to illuminate its internal workings. This project works to quantify cytokinetics experimentally to determine the effects of environmental challenges. Original software was written to determine a differential image consisting of the time derivative of pixel intensities at every timepoint. Pixels in the differential image were summed to create an integrated time vs. intensity plot. Two chemical challenges were used: Paraformaldehyde (fixative) and sodium fluoride (NaF, metabolic toxin). The presence of both of these challenges has been demonstrated by quantitative cytokinetic data which shows a difference between blank, baseline motion, and challenge ($n = 6$, $P < 0.05$). Differences in NaF concentration were reflected by different rates of change in cytokinetic transient periods ($n = 2$, $P < 0.05$). Quantitative cytokinetic data may offer a useful tool for the illumination of cellular conditions and extracellular challenges.

AN EASY WAY TO APPROXIMATE A PENTAGONAL DODECAHEDRON FROM A CUBE. ***Chin-Zue Chen***, *Austin Peay State University, Clarksville, Tennessee.* With four simple cuts on each of the three parallel pair surfaces, in a total of 12 cuts, a cube can be cut to approximate a pentagonal dodecahedron. The method of cutting and approximation were analyzed and discussed.

THE DEVELOPMENT OF INTELLIGENT SYSTEMS USING SOFT COMPUTING ALGORITHMS. ***Ashraf Saad and Adel***

***Salama**, Armstrong Atlantic State University, Savannah, Georgia, and Austin Peay State University, Clarksville, Tennessee.* We give an overview of the development of intelligent systems using soft computing algorithms that include self organizing maps, Bayesian networks, genetic algorithms, fuzzy logic, and neural networks. These algorithms have been advantageous for many application domains of intelligent systems such as modeling and control, diagnosis, and pattern recognition. Recent developments in the field have been presented at related conferences, such as the 11th and 12th Online World Conferences on Soft Computing in Industrial Applications (*http://www.cs.armstrong.edu/wsc11*). The talk gives an overview of state-of-the-art advances and promising future directions in the field including an overview of recently developed hybrid soft computing algorithms.

ENGINEERING TECHNOLOGY DEPARTMENT AT AUSTIN PEAY STATE UNIVERSITY. ***Adel Salama**, Austin Peay State University, Clarksville, Tennessee.* The Engineering Technology Department at Austin Peay State University, Clarksville, Tennessee, did extensive curriculum revisions that incorporate novel content, concentrations' organization and program of study. The engineering technology curriculum must be kept current to meet industry needs and to attract students. The engineering technology faculty regularly review and update the program curriculum to achieve desired learning outcomes and to meet Accreditation Board for Engineering and Technology (ABET) standards for engineering technology programs (TAC). The Department Curriculum Committee reviewed and revised the curriculum based on desired program learning outcomes based on the following goals: 1) Students should have access to an excellent education in liberal arts, science, mathematics, engineering and currently applicable hands-on training in technology through concentrations offered in the degree curricula, and 2) The curricula should be driven by industry needs and closely aligned with work place practices through contacts and visits to industrial institutions.

REMOTELY ACCESSIBLE LABORATORY PRACTICES AT TENNESSEE TECHNOLOGICAL UNIVERSITY. ***Ismail Fidan**, Tennessee Technological University, Cookeville, Tennessee.* The remotely accessible laboratory environment allows the general public to perform experiments from anywhere with an Internet connection by simply submitting an experiment request through the laboratory website, *http://iweb.tntech.edu/rrpl*. Requests are submitted to the experimental queue and are then performed in the order on the equipment set-up at the Tennessee Tech University Remote Laboratory. The experimental results are produced, recorded, and mailed back to students as soon as the experiments are finished. The current practices in MIT4450 Rapid Prototyping course are reported in this presentation.

GEOLOGY AND GEOGRAPHY SECTION

PETER LI, CHAIR

WATER QUALITY IN COOKEVILLE AREA—YEAR 2 STUDY. ***Richard C. Lee, Christine W. Li, Tammy Tu, and Peter Li**, Cookeville High School, Cookeville, Tennessee (RCL, TT), Harvard University, Cambridge, Massachusetts (CWL), and Tennessee Technological University, Cookeville, Tennessee (PL).* A two-year study of the impact of land use on water quality in three local watersheds was conducted, results analyzed and presented. We found that the three watersheds near Cookeville, Tennessee (Blackburn, Spring Creek, and Pigeon Roost) have unique water quality characteristics because of their different land use patterns. These results prompted the question of consistency of the water quality in this area. We compared two-year data to show that turbidity level was worse in the second year. Chemical parameters, such as chloride, nitrate, and total dissolved solids (TDS) showed a significant increase from the year before. The findings from both years proved that the water quality in urban settings is declining. Impact from storm water and highway runoff is evident from the analytical results of constituents. ANOVA showed a significant difference among the three watersheds. A relationship between turbidity and total suspended solids was established for future reference. Biological assessment using biorecon scores from macroinvertebrate community was performed. The result of the low biorecon score found in Pigeon Roost watershed shows severely impaired water quality. Intolerance taxa, EPT and total richness of macroinvertebrate community in water were analyzed and discussed. Low impact development strategies, such as rain gardens, were proposed to help improve water quality in Pigeon Roost watershed.

CAMPUS EXPANSION FEASIBILITY STUDY USING GEOGRAPHIC INFORMATION SYSTEM. ***Brent F. Richey****, *Tennessee Technological University, Cookeville, Tennessee.* Abstract not available.

CHANGE OF CARBON INVENTORY IN A SMALL WATERSHED. ***Peter Li**, Tennessee Technological University, Cookeville, Tennessee.* Two aerial photos, 50 years apart, were used to compare land use change in a small watershed in middle Tennessee. Interviews from agricultural workers in the area of the watershed provided detailed input parameters to DNDC (a carbon inventory model). Climate data from NOAA over 50 years were used to process the model. Analysis of temperature data shows a warming trend in the Cumberland area of Tennessee. Diurnal temperature range showed a decreasing trend over 50 years. Minimum daily temperature appeared to increase by 3.65°F per century and maximum temperature increased by 1.46°F, yielding a decrease in diurnal temperature range. Results show a decreasing trend in carbon released to the air throughout the planting period. Fifty-year model no-tilt simulation results show that the soil organic carbon emission rate would be 90% lower after 20 years. After 50 years of crop rotation between hay and corn, 118 kgC/ha/year was found in the growing field. Deep tilt method generates higher carbon output, verified by this model. A comparison model showed 3 times higher soil carbon was released to the air at the end of 50 years. Seventeen percent of land in a rural watershed, in Tennessee, was converted from agriculture to developed area. Population increase between 1990 and 2000 is estimated at 21%. More agriculture land would eventually be converted to developed area for residential, industrial and commercial purposes. Total carbon emission rates were estimated and future scenarios are presented in the study.

DISTRIBUTION OF SILICON PHASES WITHIN THE VARIOUS FACIES OF THE MINE ROCK AT FRANKLIN INDUSTRIAL MINERALS OPERATION, CRAB ORCHARD,

TENNESSEE. ***Amy L. Herren***, *Tennessee Technological University, Cookeville, Tennessee.* Abstract not available.

GEOGRAPHIC DISTRIBUTION OF OLD, HIGH-LEVEL ALLUVIAL DEPOSITS IN EAST-CENTRAL TENNESSEE AND IMPLICATIONS FOR ORIGIN. ***J. L. Gentry****, *Tennessee Technological University, Cookeville, Tennessee.* Abstract not available.

MODELING LAND USE CHANGE IN CANE CREEK WATERSHED USING GIS. ***Gregory J. Rhinehart****, *Tennessee Technological University, Cookeville, Tennessee.* GIS techniques were applied to compute change of land use types in Cane Creek watershed in Putnam County. Printed aerial photos from 1955 were scanned, georeferenced, and matched to a recent aerial photo. Raster images of land use coverage were digitized into vector format before being converted to raster-formatted images for spatial analyses of the change types. Final results were used as an input parameter for a carbon sequestration model. Results show the trend of urbanization, and loss of agriculture land to developed area, 21% of the entire watershed. The product of this research will enhance understanding of other topics, such as carbon sequestration, urbanization, deforestation, and loss of farmland.

HEALTH AND MEDICAL SCIENCES SECTION

J. MICHAEL REDDING, CHAIR

EFFECTS OF TWO DIFFERENT TYPES OF CELLULAR PHONE CONVERSATIONS ON GAIT CHARACTERISTICS WHILE WALKING. ***Tara L. McDonough****, ***C. Steven Murphree, and Nancy S. Darr***, *Belmont University, Nashville, Tennessee.* The purpose of this study was to examine the effects of two different types of cellular phone conversations on gait characteristics and gait safety of healthy young adults while walking. Gait characteristics of subjects were recorded using a GaitRite® mat. Subjects walked across the mat under three conditions: 1) without a cellular phone, 2) engaged in a social conversation on a cellular phone, and 3) engaged in a conversation which involved solving arithmetic equations over a cellular phone. Subjects then filled out a questionnaire to evaluate their everyday use of cellular phones and the extent this use affects social and physical aspects of their lives. Preliminary data demonstrated that gait speed was reduced and gait variability was increased during the dual tasks of walking and talking on a cellular phone. This supports the conclusion that talking on a cellular phone while walking reduces gait safety.

DEVELOPMENT OF NATURAL CANCER FORMULATIONS. ***Jesse T. Purvis****, ***J. Clint Stanfill****, ***William H. Peeples, Daniel J. Simons****, ***Jerry T. Thornthwaite***, *Freed-Hardeman University, Henderson, Tennessee and Cancer Research Institute of West Tennessee, Henderson, Tennessee.* Classical cancer treatments do not encompass three natural anti-cancer activities: antioxidation, antiangiogenesis, and Natural Killer Cell (NKC) stimulation. Our Formulation includes all three natural processes and is intended for use as a supplement to current treatment modalities. Formulation composition was based on the large number of publications and experimental successes showing the over-the-counter components are successful cancer treatment with minimal side effects. The antioxidants of the Formulation include natural substances widely-known for their far-reaching properties. Angiogenesis is crucial for tumor expansion; however, the ingredients NAC, genistein, and others appear instrumental to antiangiogenesis. Other ingredients, Arabinoxylan (bran) and Lentinan (shitake mushrooms), stimulate NKCs. The Formulation is making inroads in the treatment of cancer patients as a prophylactic after cancer treatment and in prevention for seemingly healthy individuals. The Formulation utilizes published pure, natural compounds to synergistically increase antioxidant, antiangiogenic and NKC activity against cancer.

DNA FLOW CYTOMETRIC ANALYSIS OF HUMAN OVARIAN BENIGN AND MALIGNANT TISSUES. ***J. Clint Stanfill****, ***Ahmed S. Ahmed, and Jerry T. Thornthwaite***, *Freed-Hardeman University, Henderson, Tennessee, Cancer Research Institute of West Tennessee, Henderson, Tennessee, and Manchester Hospital, Manchester, England.* We evaluated aggressiveness of primary cancer and benign ovarian tissues using DNA Histogram type. Paraffinated samples were subjected to deparaffination and enzymatic dissociation using high resolution electronic cell volume DAPI fluorescence analysis. Trout erythrocyte DNA standards were mixed with the samples for accurate normalization of DNA values. Mean coefficient of variation (CV) of the human paraffinated tonsil control had a DNA $CV_{AV} \pm SD = 2.18 \pm 0.46$ ($n = 22$). Mean $\pm$ *SD* DNA index of tonsil/trout $G_{0/1}$ ratio peaks was 1.42 ± 0.03. These high resolution standards allowed classification of benign and cancer samples into five DNA types: DIP ("good" prognosis), HYPO, HDIP, MULTI, and HTET ("poor" prognosis). Of the benign patients, 14.3% ($n = 21$) fell within the "poor" group, while 64% of the cancer patients ($n = 50$) were "poor". Ovarian cancer is very aggressive. "Poor" benign cases represent a significant subpopulation with DNA aneuploidy; this may warrant patient reassessments.

T-CELL CYTOKINES.... ***Dale S. Carter***. Belmont University, Nashville, Tennessee. No abstract available.

HISTORY OF SCIENCE SECTION

JAMES X. CORGAN, CHAIR

USING TENNESSEE STATE LIBRARY AND ARCHIVES 19TH-CENTURY RESOURCES. ***Carol Roberts***, *Tennessee State Library and Archives, Nashville, Tennessee.* The rich land and multiple climates of the Tennessee valley drew the long hunters and explorers to Tennessee. The potential for farming and crops encouraged the early pioneers to settle and kept them on the land. Early progressive leaders in agricultural business such as Gerard Troost, Tolbert Fanning and Joseph Killebrew helped establish Tennessee's long tradition of farming as a way of life, progressive techniques, and cooperative organizations of agribusiness of today. The Tennessee State Library and Archives (TSLA) maintains a wide variety of materials that help researchers learn about Tennessee's richest supplies of natural resources and agricultural heritage. The journals, maps, photographs, state records, and manuscripts reflect the history of the land as well as the farmers who worked it. These documents

reflect the earliest record keepers' materials that encouraged 19th century immigration for the purpose of an agricultural life, encouraged various crop production, and encouraged the use of diverse natural resources for early industry.

WEATHER ALONG THE TRAIL OF TEARS. ***Mark A. Rose***, *National Weather Service, Old Hickory, Tennessee*. Those who have studied the Trail of Tears know that weather conditions were agonizingly harsh. The period discussed in this paper covers the summer of 1838 until the spring of the following year. Unfortunately, meteorological records of temperature and precipitation do not exist. Weather records for Nashville, Tennessee, which boasts the longest period of record in Middle Tennessee, date to 1870, more than three decades after the emigration. Thus, the only information on meteorological conditions experienced along the trail are those scant reports included in journal accounts by those who were present. No temperature or precipitation measurements are available, and one is left to wonder the exact magnitude of those conditions. The available meteorological information describes three distinct seasonal periods through which the Cherokees were routed: an extreme summer drought, a harsh, wet autumn, and an insufferably cold winter. Based on the limited accounts available, the author will attempt to weave together a description of the meteorological events that brought about the unusual seasonal extremes endured by those on the Trail of Tears endured.

SOME SOURCES FOR THE HISTORY OF SCIENCE AND TECHNOLOGY IN TENNESSEE. ***James X. Corgan***, *Austin Peay State University, Clarksville, Tennessee*. Biographical resources underlie many historical studies. The American Chemical Society and other national groups issue biographical volumes that include Tennesseans. The State Library has a card index with about 15,000 biographies of Tennesseans. The State Archives preserves many records including discontinuous Tennessee Academy of Science files from 1912 onward and an aborted 75th anniversary study. The Archives has minutes of other groups such as the Antiquarian Society, Tennessee's first scientific organization. *The Tennessee Encyclopedia*, *Journal of the Tennessee Academy of Science*, *Tennessee Medicine*, *Tennessee Conservationist*, *Tennessee Historical Quarterly*, and other journals occasionally treat history of science and technology. The Tennessee Division of Geology, the Army Corp of Engineers, and other scientific and technical agencies issue historical reports. For students of the history of science and technology in Tennessee vast resources are available.

DERIVATION OF KEPLER'S EQUATION. ***Brother Kevin J. Ryan***, *Christian Brothers University, Memphis, Tennessee*. Kepler's First Law (the ellipse) and Kepler's Second Law (equal area in equal time) are well known. What is not well known, is the method to use these Laws to make a computation of a future position of a planet. One step in this computation is Kepler's Equation: $M = E - e\sin E$. The derivation of this equation will be shown.

ROBERT OPPENHEIMER: HIS LIFE AND ITS PORTRAYAL IN THE MEDIA FROM 1953 TO 1954. ***Lisa Bovee****, *Tennessee Technological University, Cookeville, Tennessee*. Robert Oppenheimer's eventful and dramatic life will always be a source of controversy, and this was represented especially in the media at the time of his security hearings. A broad spectrum of views on Oppenheimer's personal activities with the Communist party and as a premier scientist were expressed in many different sources, including *The New York Times*, *Science*, *Life*, *Time*, and *U.S. News and World Report*, from upholding his status as a patriotic citizen to charging that he was a possible Soviet spy. Studying the media at the time of the trial is a testament to how Dr. Oppenheimer was a symbol of the growing unrest in the nation due to the Cold War.

SCIENTIFIC AMERICAN GOES TO WAR, 1914. ***George E. Webb***, *Tennessee Technological University, Cookeville, Tennessee*. Although the United States would not enter the First World War until April 1917, Americans watched the unfolding European conflict from its beginning in August 1914. Those observers interested in the scientific and technological aspects of the war had access to detailed discussions of these developments through the pages of *Scientific American*, which examined a wide variety of topics. Not only did the editors of this periodical report on technological developments such as the use of aircraft and mechanized vehicles, but they also discussed the economic impact of the war on the United States and the loss of valuable members of the scientific community on the battlefield. An examination of this periodical's coverage of the first five months of the conflict reveals a previously unexplored chapter in America's introduction to the war in Europe.

MATHEMATCIS AND COMPUTER SCIENCE SECTION

BOB FORRESTER, CHAIR

4-MOVE EQUIVALENCE OF KNOTS UP TO 10 CROSSINGS. ***Ramanjit K. Sahi, Mieczyslaw K. Dabkowski, and Noureen A. Khan****, *Austin Peay State University, Clarksville, Tennessee (RJS) and University of Texas at Dallas, Richardson, Texas (MKD, NAK)*. We study on 4-move equivalence classes of knots. We extend the results concerning reducibility of knots by 4-moves, that is, we show that Nakanishi's conjecture holds for all knots up to 10 crossings, all knots in family 6*, and knots obtained as a closure of any 3-braid with at most two successive clasps.

POISSON PROCESS MODELS FOR A COMBINATION OF POINTS AND COUNTS IN SPACE. ***Han Wu and Mark S. Kaiser***, *Austin Peay State University, Clarksville, Tennessee and Iowa State University, Ames, Iowa*. Techniques have been developed for estimating the parameters of spatial point process, given data at either the aggregate or point levels. However, it remains unclear how to model aggregate data (counts for sections) with a subset of point data (exact locations of some events). This study investigates a nonhomogeneous Poisson process on $A \cap Rd$ with intensity function $\{\lambda(s; \theta): \theta \in \Theta\}$. The intensity function may depend on some spatial variable, spatial locations alone, or both. We propose a model for a mixture of an aggregate and point data to accommodate both aggregate level and point level information if possible. It turns out that the proposed model for combined data forms is useful if spatial covariates are available. The combined model appears to give better estimates of parameters in the intensity than does a model only based on aggregate (count) data. The study also shows that

the more exact locations we know the more precise maximum likelihood estimates become for parameters of the underlying process.

A SEMIPARAMETRIC APPROACH TO LINEAR REGRESSION. ***M. Allen and D. Long***, *Tennessee Technological University and University of North Carolina, Chapel Hill, Chapel Hill, North Carolina.* One of the assumptions in simple linear regression is that the error terms are normally distributed. But if the error terms are not normally distributed, this causes a problem with the inference for the parameter estimates. One method to combat this problem is to use semiparametric regression. Semiparametric processes make assumptions regarding the parameters of the error distribution but do not assume a specific distribution. By reconstructing and expanding a previous semiparametric approach to one-way ANOVA, a new process for finding maximum likelihood estimators (MLE's) for the regression parameters is created. Using these semiparametric MLE's, a new process to test for linear regression is devised. This test is compared to the test for classical simple linear regression.

ACTION OF REAL FORMS OF SEMI-SIMPLE LIE GROUPS ON COMPLEX FLAG MANIFOLDS. ***B. Ntatin***, *Austin Peay State University, Clarksville, Tennessee.* Actions of Lie groups on manifolds normally give rise to induced actions on the parameter spaces of geometric objects that are related to the manifolds in question. For example, from the usual representation of $SLn(\mathrm{R})$ on C^n, one obtains actions on the parameter spaces of linear subspaces, that is, Grassmannians $Gr_K(\mathrm{C}^n)$ of k-dimensional subspaces of C^n, flag manifolds $\mathrm{F}_{1,\ldots,k}(\mathrm{C}^n)$ and so on. These in turn define new representations on associated spaces of functions, sections in bundles, differential forms among others. In this talk, parameter spaces of certain nonlinear geometric objects (cycles) in the natural setting of group actions will be described. We will use low dimensional examples for easy illustration. Although the objects we will consider are quite concrete, the ideas used could be extended in full generality.

A FIVE-STEP LINEAR MULTISTEP METHOD FOR THE NUMERICAL INTEGRATION OF THE TIME INDEPENDENT WAVE EQUATION. ***Joshua W. Henry* and Samuel N. Jator***, *Austin Peay State University, Clarksville, Tennessee.* A five step linear multistep method with continuous coefficients is developed and used to generate Multiple Finite Difference Methods which can be combined as simultaneous numerical integrators for initial value problems. In particular, the method is applied directly to the time independent wave equation as it models the interaction of a collimated monochromatic beam of light with different types of materials. Initial conditions are determined as they apply to the physical situation. The polarizability and composition of the target material is incorporated into the calculation. Results are compared with analytical predictions of the same interaction.

DIRECT INTEGRATION OF SECOND ORDER DIFFERENTIAL EQUATIONS BY A FIVE-STEP BACKWARD DIFFERENTIATION FORMULA. ***Amy E. Dexter* and Samuel N. Jator***, *Austin Peay State University, Clarksville, Tennessee.* A five-step Backward Differentiation Formula is developed and applied to second order ordinary differential equations (ODEs) of the form $y'' = f(x,y,y')$. The main method is derived by interpolation and collocation of the assumed approximate solution and its second derivative at selected grid points. This process leads to a system of (k+1) (where k is the step number of the method) equations, which is solved to determine the unknown continuous coefficients. The resulting coefficients are used to construct the approximate solution from which several methods are generated and simultaneously applied to provide a direct solution for ODEs. Numerical experiments are given to show the efficiency of the methods.

MICROBIOLOGY SECTION

CHAD BROOKS, CHAIR

ISOLATION AND IDENTIFICATION OF TOLUENE-DEGRADING MICROORGANISMS. ***Michelle Drury* and John M. Zamora***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Toluene is a volatile, water insoluble, aromatic hydrocarbon commonly used as an industrial solvent for paints, inks, and lacquers; it is subject to slow biological degradation. A recent toluene spill in Franklin, Tennessee allowed for unique study of microbial toluene degraders. Several laboratory strains of microorganisms, as well as soil and water isolated microorganisms from the Franklin, Tennessee, toluene contamination sites, were studied for efficient toluene degradation. The microorganisms were plated onto tryptic soy agar containing different concentrations of toluene (TTSA) in order to determine the toxicity of toluene. The TTSA medium was very inhibitory at higher tolune concentrations. These microorganisms were then plated onto minimal salts agar containing toluene (TMSA) to determine the selectivity of this media. The TMSA exhibited greater inhibitory traits when compared to TTSA medium. Microbes capable of growing on both TTSA and TMSA were further isolated and identification was attempted. Resulting natural and laboratory strain isolates may be useful for phyto-remediation and bio-remediation of toluene.

ANTIMICROBIAL AND ALLELOPATHIC PROPERTIES OF *ORIGANUM VULGARE*. ***Matt Goff* and John M. Zamora***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Plants have long been used as a means of curing illness and healing people. Many plants have been known to exhibit antibacterial, antifungal and/or antiviral activity. Oregano (*Origanum vulgare*) has been suggested as a cure for athlete's foot, diarrhea, influenza, as well as other ailments. The purpose of this study was to see if extracts of this plant had antimicrobial or allelopathic activity. Antimicrobial tests were done using alcoholic extracts of oregano. These extracts were inhibitory to bacteria and fungi. The hot water extract of *Origanum vulgare* inhibited bean sprout growth. This assay is used as a screening test for allelopathy. Statistical analysis indicated that the difference in size was significant. It appears that there are antimicrobial and allelopathic chemicals in *Origanum vulgare*.

ANTIMICROBIAL AND ALLELOPATHIC PROPERTIES OF *CAMELLIA SINENSIS*. ***Nazra Haniff* and John M. Zamora***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Many plants possess phytochemicals that are antiviral, anticancer, allelopathic, and antibacterial. *Camellia sinensis* is the plant from which black tea, white tea and green tea is made. The difference between green tea, black tea, and white tea is in how

the plant is processed. The purpose of this study was to see if extracts of this plant had antimicrobial, allelopathic, or antiviral activity. Antimicrobial tests were done using alcoholic extracts of green tea, black tea, and white tea. These extracts were inhibitory to some bacteria. There were differences among the different teas. The hot water extracts of *Camellia sinensis* inhibited the growth of bean sprouts. This assay is used as a screening test for allelopathy. It appears that there are allelopathic chemicals in *Camellia sinensis*. Hot water extracts also were tested for antiviral activity against T4 phage. The extracts did lower the number of plaque forming units per mL. This indicated antiviral activity. There were differences among the green tea, black tea, and white tea.

COMPARATIVE ANALYSIS OF DNA-BASED ASSAYS AND ANTIGEN/ANTIBODY ELISA FOR DETECTION OF *DIROFILARIA INMITIS*—HEARTWORM DISEASE. ***Jarillys M. Marin* and Chad S. Brooks***, *Austin Peay State University, Clarksville, Tennessee.* Commercial enzyme-linked immunosorbant assays (ELISA) specific for detecting *Dirofilaria immitis*, heart worms, was compared to specific primers used in polymerase chain reactions (PCR) to evaluate a better detection method for heart worm infected dogs found in middle Tennessee. Adding to the novelty of the PCR assays were the utilization of specific *Wolbachia* primers. Similar to the *Wolbachia* bacteria found in *Wuchereria bancrofti*, which causes human lymphatic filariasis, these related bacteria are found in a symbiotic relationship with *D. immitis*. PCR using specific *D. immitis* and *Wolbachia* primers revealed heart worm infection could not be deduced using PCR-based assays while ELISA indicated infection. Explanations, conjectures and methodology will be discussed.

ENDEMICITY OF *BORRELIA BURGDORFERI* IN TICKS FROM MONTGOMERY COUNTY, TENNESSEE. ***Christina L. Russell* and Chad S. Brooks***, *Austin Peay State University, Clarksville, Tennessee.* Lyme disease caused by the pathogenic bacterium *Borrelia burgdorferi* is the most common vector-borne disease in North America. *Borrelia burgdorferi* is maintained in nature by a complex enzootic life cycle between ticks and different mammalian hosts. Research generated in the summer of 2006 while analyzing greater than 300 animals for *B. burgdorferi* infection revealed that no adult *Ixodes scapularis* ticks were found parasitizing these animals. The deer tick, *I. scapularis*, is believed to be the principle tick-vector for *B. burgdorferi* in the Eastern United States. Therefore, the notion that *B. burgdorferi* could be perpetuated by other tick species was evaluated. Analysis of collected ticks from 2007 showed that 36% of all collected ticks harbor *B. burgdorferi* DNA and all of these ticks were identified as *Dermacentor variabilis*, the American dog tick.

EVALUATION OF MELITTIN AS A NOVEL DRUG THERAPY FOR LYME DISEASE. ***Joseph W. Vazquez* and Chad S. Brooks***, *Austin Peay State University, Clarksville, Tennessee.* *Borrelia Burgdorferi* is the bacterium responsible for Lyme disease. In the absence of a vaccine, infected people must rely on antibiotics to cure them from *B. burgdorferi* infection. However, antibiotic therapy is not always efficacious, which warrants exploration of novel therapeutics. A prior study revealed that *B. burgdorferi* was susceptible to melittin, a metabolic inhibitor. Melittin is a 26 amino acid peptide and the primary component of honeybee venom. This study explores melittin as a potential therapy for infected Lyme disease patents. In vitro analysis was performed to determine the bactericidal effects of melittin on *B. burgdorferi* in preparation for in vivo work. In vitro, a minimum of 100 ng/mL of melittin was necessary to kill 1×10^6 *B. burgdorferi* organisms in 15 min. *B. burgdorferi* infected mice were subsequently administered 500 ng of melittin to determine the therapeutics of melittin. In vitro and in vivo data will be discussed.

HOW SAFE IS THE FOOD IN YOUR REFRIGERATOR? ***Sandria L. Godwin, FurChi Chen, and Richard J. Coppings***, *Tennessee State University, Nashville, Tennessee.* Foodborne illness has been linked to consumer food handling and storage practices. Proper refrigeration can inhibit microbial growth in many foods. Temperature loggers were placed in 200 home refrigerators. Thermo couples also were placed in two foods in some refrigerators. In a follow-up study 147 refrigerators were evaluated for cleanliness and a total of 369 microbial swabs were collected. The top shelf was the coldest area in the tested refrigerators followed by the bottom shelf and the door. A significant proportion of these areas had mean temperatures in excess of the recommendation. Mean food temperatures were slightly lower than, and fluctuated less than, those of the surrounding air. Approximately one third of swabs had significant aerobic and psychrotrophic microbial counts. Cleanliness scores were correlated with microbial numbers on the bottom refrigerator shelf. Consumers need to be aware of their responsibility for maintaining food safety.

HYDROGEN PRODUCTION BY ALGAE AND CYANOBACTERIA IN HOLLOW-FIBER PHOTOBIOREACTORS. ***Chris Wilkins*, Michael Seibert, and Sergei A. Markov***, *Austin Peay State University, Clarksville, Tennessee (CW, SAM) and National Renewable Energy Laboratory, Golden, Colorado (MS).* For six months, we have operated two hollow-fiber photobioreactors continuously for the production of H_2 using two metabolically distinct forms of photosynthetic microorganisms. Growth medium was pumped into the photobioreactor volume outside the hollow fibers, and the cells were immobilized on the outside surface of the fibers. Medium flowed into the hollow-fiber inner space and then out via external tubing to a gas trap, where H_2 was separated from the medium. Light intensity was 15 $\mu mol \cdot m^{-2} \cdot s^{-1}$. One photobioreactor utilized hydrogenase activity of the green alga, *Chlamydomonas reinhardtii* CC-503, cw92 [mt+]. Hydrogen production was observed under partial vacuum at an average rate of 6.0 $ml \cdot g\ cdw^{-1} \cdot h^{-1}$. The second utilized the nitrogenase activity of the cyanobacterium, *Anabaena variabilis* PK84, a mutant lacking uptake hydrogenase activity. It showed an average rate of H_2 photoproduction of 9.1 $ml \cdot g\ cdw^{-1} \cdot h^{-1}$. Notably, H_2 production was achieved under ambient conditions in the presence of dissolved O_2.

DETECTION AND DIFFERENTIATION OF *BORRELIA* SPECIES USING A NOVEL NON-FLUORESCENCE BASED BIOSENSOR. ***Katherine A. Barber*, Nathaniel F. Brady*, William M. Robertson, and Stephen M. Wright***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Lyme Disease, caused by the bacterium *Borrelia burgdorferi*, is the leading vector-borne illness in the United States. Southern Tick Associated Rash Illness, caused by the closely related *Borrelia lonestari*, is often mistaken for Lyme Disease. Probe differentiation of these *Borrelia* species was achieved using an optical

biosensor that is based on the shift in Surface Electromagnetic Wave resonance in Photonic Band Gap (PBG) coated slides. Both species' DNA were amplified and applied to a PBG-coated slide as a microarray. The biosensor laser scanned the DNA array to produce a three dimensional topographic array image. A species-specific probe lacking a fluorescent label was added and, when rescanned, a change in spot height was indicative of hybridization. The use of the biosensor versus fluorescent labeling presents a method of detecting biological molecule binding that is quick, sensitive, and specific. This novel sensing technique has significant applications in health care, law enforcement, and research.

COMMONALITY OF METHICILLIN-RESISTANT *STAPHLOCOCCUS AUREUS* IN HOSPITALS AND RESTAURANTS. ***Kelienne M. Verdier* and Jennifer T. Thomas***, *Belmont University, Nashville, Tennessee. Staphylococcus aureus* is a gram-positive bacterium commonly found on the skin and in the nose of people and animals. Of recent concern is the increase in the incidence of methicillin-resistant *S. aureus*, MRSA, which is a type of *S. aureus* that is resistant to the antibiotic, methicillin. MRSA has traditionally been one of the leading causes of nosocomial (hospital-acquired) infections, but has most recently been associated with infections in other settings. Because of the MRSA increase in community settings, I chose to examine the commonality of MRSA in restaurants compared to hospitals. Preliminary evidence indicates that *S. aureus* isolates are much more common in restaurants than hospitals. Ongoing work is examining the presence of the MecA gene, the gene responsible for methicillin resistance, in the isolates. We can then determine the percentage of *S. aureus* isolates from a given location that are MRSA.

DETECTION AND ELIMINATION OF *ESCHERICHIA COLI* FROM SPINACH. ***Andrew Handerson*, Bahareh Tahriri* and John M. Zamora***, *Middle Tennessee State University, Murfreesboro, Tennessee. Escherichia coli* is a small Gram-negative bacterium that can be found in raw meat and poultry. This organism is found in the intestinal tract of animals and man. Most of the food industries test for the presence of *E. coli* in food because its presence indicates fecal contamination of food. Recently *E. coli* was isolated from bagged spinach. Our purpose was to compare the concentration of *E. coli* from bagged spinach before and after several washing procedures. The washing procedures included deionized water, tap water, salty water, a bisulfite solution, and a percarbonate solution. A conventional isolation procedure for intestinal bacteria and *E. coli* requires that a dilution of the food sample be cultured on a selective medium (MacConkey Agar) at 37°C for 2 days. Intestinal bacteria and *E. coli* were isolated from the bagged spinach. All of the washing procedures lowered the number of bacteria as well as the number of intestinal bacteria to some extent.

PHYSICS AND ASTRONOMY SECTION

LIONEL CREWS, CHAIR

NANOFABRICATION THROUGH INTENSIFIED PLASMA ASSISTED PROCESSING. ***Mary Gibbs* and Eugene de Silva***, *Lincoln Memorial University, Harrogate, Tennessee.* Intensified plasma assisted processing (IPAP) is a surface modification technique. It was first developed by Meletis (1994) to generate low-temperature, low-pressure nitrogen diffusion treatments. In IPAP, a triode glow discharge is used to achieve plasma intensification and energetic flux bombardment. Many of the base materials used in the automotive and aerospace industry cannot tolerate high temperature used in techniques such as Chemical Vapor Deposition (CVD). An attractive alternative to high temperature CVD is to use a new technology called high energy intensified plasma assisted processing (HEIPAP). This paper describes a modified version of IPAP, first developed by de Silva (1998). The modified version includes a system coupled with an RF supply. This version has enabled the nitride processing to be conducted at relatively low temperatures. Experimental results on aluminum substrates are presented where significant improvements in surface-sensitive properties have been achieved. The coatings on substrates have shown improvements in wear resistance.

WEATHER OBSERVATIONS USING A SMALL SOUNDING ROCKET. ***Tolulope Fatokun*, Rudy Gostowski, and Kent Wallace***, *Fisk University, Nashville, Tennessee (TF, KW) and Marshall Space Flight Center-NASA, Huntsville, Alabama.* The purpose of the experiment was to measure changes in atmospheric pressure, relative humidity, and wind speed and direction with increasing altitude up to 5,280 ft using a student-built sounding rocket. The rocket carried an external thermocouple to measure atmospheric temperature; a digital humidity sensor to measure the relative humidity; and a global positioning satellite receiver to determine wind speed and direction. The pressure sensor on board the flight computer determined the atmospheric pressure. The flight computer collected, stored and communicated all data to the ground in real time by a telemetry transmitter. The data collected was compared to similar information from the National Weather Service.

SCIENCE AND MATHEMATICS TEACHING

JENNIFER THOMAS, CHAIR

APPLIED RESEARCH IN PHYSICS. ***Eugene de Silva and Athena Jzero Canfield****, *Lincoln Memorial University, Harrogate, Tennessee.* This presentation describes a novel approach to science teaching by bringing examples from physics. Previous work done by de Silva (2000), confirmed the main expectations of adult learners who enter higher education. This work further established a way to increase the number of chemistry learners by highlighting the life-skills that can be learned through chemistry. A three-year study was initiated in 2004 to establish novel approaches to teaching (de Silva, 2006), and the core learning objectives were identified (DfES, 2006). The introduction of subject matter, supplement to improving life skills has generated greater interest among learners. In this presentation, the importance of research based teaching is explained as the way forward in future teaching. An example of a mini research project also will be discussed as a way to promote critical thinking. This presentation also will highlight how physics lessons can be presented using research from other fields.

A THREE-SEMESTER SEQUENCE FOR UNDERGRADUATE RESEARCH. ***Lori L. McGrew***, *Belmont University, Nashville, Tennessee*. Evidence suggests that undergraduate research facilitates student learning both by increasing student interest/motivation and by fostering critical thinking skills through application of the scientific method. In the biology department at Belmont University, we are utilizing a three-semester sequence for undergraduate research projects. In this model, during the first semester, students write a research proposal and practice scientific communication skills. Then during the second semester, the students conduct the appropriate experiments, record, and analyze data. Finally, during the third semester, the students prepare both oral and written presentations of their research projects. We feel strongly that this model increases both the quality of student projects and student learning over a one-semester undergraduate research model.

STUDENT ROCKET TEAM. ***Rudy Gostowski and Kent Wallace***, *Marshall Space Flight Center-NASA, Huntsville, Alabama and Fisk University, Nashville, Tennessee*. A team of Fisk University students designed, built, flew and recovered a reusable sounding rocket carrying a scientific payload to an altitude of one mile. At the same time, the team conducted science outreach for area elementary and middle school students. Nearly one thousand K–8 students from seven middle Tennessee schools learned about the history of the United States Space Program, built and launched payload-carrying rockets, and gained an appreciation of science careers. These activities were the team's submission to the University Student Launch Initiative program administered by the Marshall Space Flight Center Education Office. Over twenty undergraduate and graduate students, five of which were female, from majors such as Chemistry, Physics and Computer Science worked in an area outside their previous experience while participating in the service activity of science education.

DIFFERENTIATED INSTRUCTION IN THE SCIENCE CLASSROOM. ***Leigh Gostowski***, *Middle Tennessee State University, Murfreesboro, Tennessee*. Differentiated instruction is an approach to teaching and learning that recognizes the varied background knowledge, readiness, native language, and interests of students, and allows for multiple pathways to common goals. One strategy for differentiating instruction is tiered instruction, where students engage in activities designed at different levels of complexity, enabling individualized instruction. Long used in gifted education, it is perhaps more powerful when used in a regular education or inclusion classroom. In this preliminary investigation, implemented at a middle school with a high percentage of students from low-socioeconomic backgrounds, students were assessed before beginning a teaching unit through formal or informal means. Based on these assessments, students were counseled individually to select from the three tiers of activities to complete at their own pace, individually or in small groups. This strategy resulted in increased student interest in science, and, in some cases, observable improvement over expectations.

USING BIOGRAPHIES OF SCIENTISTS AND A CONSTRUCTIVIST APPROACH TO TEACHING UNDERGRADUATE SCIENCE COURSES. ***A. Darlene Panvini***, *Belmont University, Nashville, Tennessee*. Biographies of scientists provide an excellent forum for teaching students the process of science while keeping them engaged and interested in the drama of real people engaged in scientific inquiry. As the sole texts for the course, biographies allow students to approach science through a historical and interdisciplinary lens, which leads to an understanding of the significance of major breakthroughs in scientific thought and the cumulative aspect of science. Using a constructivist approach to discussing the biographies, coupled with a laboratory experience, students develop knowledge content, process skills, context, and application skills. Syllabi, sample reading assignments, discussion techniques, reflective exercises, and student responses from an Honors Analytics Science Models course will be shared.

SCIENCE EDUCATION AND BUSINESS: BC3 CAMP—A MODEL PARTNERSHIP. ***Lee Rennick, Kim Sadler, Linda Gilbert, and Leigh Gostowski***, *BEP/Foundation Rutherford County Chamber of Commerce (LR), Middle Tennessee State University, Murfreesboro, Tennessee (KS, LG, LG)*. The Business, Community and Classroom Connections Academy for the Advancement of Math and Science Study (BC3 Camp) is a two-week summer program that gives 32 fifth through twelfth grade math, science, and vocational teachers onsite learning experiences from college educators and business professionals. Participants are divided into eight focus areas: Air and Aerospace, Animal Science, Energy, Forensics, Public Health, Space Science, Transportation and Water Resources. By helping the teachers gain greater understanding of the latest developments in math and science research and careers that require content mastery, they are empowered to make learning more relevant for their students. In addition, BC3 participants design inquiry-based lessons that link to their recent real-world experiences and teach those lessons to students attending the NSF-funded Academy for Young Scientists, a summer program for 150 fifth through eighth grade students.

NANO-SCIENCE WORKSHOP FOR NASHVILLE PUBLIC SCHOOL SCIENCE TEACHERS. ***Weijie Lu, Sarah Baker, and R. P. H. Chang***, *Fisk University, Nashville, Tennessee, Metropolitan Nashville Public Schools, Nashville, Tennessee, and Northwestern University, Evanston, Illinois*. Twelve teachers from metropolitan Nashville public middle and high schools attended the 2nd National Center for Learning and Teaching of Nanosciences (NCLT) nano-science workshop at Fisk University from June 18–29, 2007. Fisk University has hosted the NCLT workshop for Nashville science teachers in cooperation with Metropolitan Nashville Public Schools (MNPS). This two-week long workshop offered science teachers opportunities to work with nanoscience researchers, science educators, and learning tool experts in content development and laboratory experiments from Fisk, Vanderbilt, and Purdue Universities. The activities included: 1) lectures of the NCLT nano-modules, 2) introducing nanoscience in the classroom of 7–12 grades and curriculum development in nanoscale science, 3) hands-on experiments and activities, 4) nanoscience seminars, and 5) teacher's plans for implementation of nanoscience into their classrooms. The workshop is to promote science learning and teaching and to enhance collaborations between local universities and MNPS.

CORRELATION OF THE DENSITIES OF ANTIFREEZE CONCENTRATIONS WITH THE DROP IN FREEZING POINTS. ***Taylor L Horseman* and Barbara A Jackson***, *Tennessee Technological University, Cookeville, Tennessee*. Anti-

freeze is added to raise the boiling point and lower the freezing point of water in a car radiator. When one mole of antifreeze (ethylene glycol) is added to 1 kilogram of water, the freezing point of water is lowered by 1.86°C. The consumer antifreeze tester gives a reading of the expected freezing point of the antifreeze solution. In reality the tester is a calibrated densitometer, with the different densities of the antifreeze/water mixture correlated with the expected freezing points. In this experiment the densities of five concentrations of antifreeze solutions 25%, 35%, 45% and 55%, were determined. Antifreeze tester readings were done on each solution. The molal concentrations of ethylene glycol were calculated and the expected drop of freezing point depression was compared to the values given on the antifreeze tester. There was good agreement between the two values. However, when experimental freezing point depressions were performed, the observed values were somewhat lower than the calculated values and the tester readings.

DEVELOPMENT AND IMPLEMENTATION OF AN UNDERGRADUATE COURSE IN AGROTERRORISM: METHODOLOGY AND PEDAGOGY. ***W. Jack Caldwell, Donald L. Sudbrink Jr., and James K. Goode***, *Austin Peay State University, Clarksville, Tennessee.* Events related to 9/11/2001 revealed potential vulnerabilities to agriculture from bioterrorism. We initiated development of a new course to prepare undergraduate agriculture students to recognize, survive, and respond to acts of agroterrorism. This approach emphasized vulnerabilities and responses at the farm and agri-business levels. Faculty members attended agroterrorism training events and searched for published material to supplement our existing expertise. A plethora of information was found pertaining to foreign animal diseases, zoonotic diseases, and crop diseases. While all materials were not suited to the course, we were able to glean useful information from agriculture extension sources and take advantage of online training. The course has a neighborhood-watch approach to agroterrorism detection and response by farmers and agri-business. It emphasizes preparation through premises identification, interaction with first responders, and cached information and maps identifying hazardous substance storage, power cutoffs, and water sources. Students received extension certification in agroterrorism preparedness.

GRITS: A DISSEMINATION PROJECT TO ENCOURAGE GIRLS RAISED IN TENNESSEE SCIENCE. ***Judith M. Iriarte-Gross and Karen Claud***, *Middle Tennessee State University, Murfreesboro, Tennessee.* The low rate at which women are entering the Science, Technology, Engineering, and Math (STEM) pipeline in Tennessee is disturbing. The importance of education, training, and careers in STEM was noted by the Tennessee Economic Council on Women in a 2005 report which stated that STEM education and training are the keys to financial independence for women. These findings hold true not only for Tennessee but for our nation. At Middle Tennessee State University, we have addressed these concerns with an NSF funded program, called GRITS: Girls Raised In Tennessee Science. The major goal of GRITS is to disseminate information about STEM education and careers to girls in middle and high school, their parents, teachers and guidance counselors. GRITS offers a variety of activities and programs such as the GRITS Traveling Roadshow, Expanding Your Horizons, and the GRITS website, (*www.mtsu.edu/~grits*) which provide information for girls about exploring and understanding the importance of STEM education and careers.

WHAT WE HAVE LEARNED FROM SCIENCE EDUCATION FOR NEW CIVIC ENGAGEMENTS AND RESPONSIBILITIES SINCE SSI 2005. ***M. R. Weller, J. M. Iriarte-Gross, J. Swoner*, and T. Sutarso***, *Middle Tennessee State University, Murfreesboro, Tennessee.* Science Education for New Civic Engagements and Responsibilities (SENCER), is an NSF sponsored program that aims to interest more students in STEM learning. Students in SENCER courses are also encouraged to connect STEM concepts to current civic issues. The Middle Tennessee State University (MTSU) SENCER team has been involved in SENCER since fall 2005 and is moving forward with the development of a new general education physical science course titled: Energy, Earth, and Civilization. In this course, students explore the scientific, environmental, economic, social and moral issues surrounding the use of solar, organic and nuclear energy. Student activities range from traditional lectures and lab activities to group problem-solving to research-based papers and class discussions. This course addresses all of the goals of MTSU's general education science component. We will discuss our preliminary results from formal interviews, scientific attitude surveys, the SENCER SALG, and anecdotal comments from our first groups of students.

ELEVEN YEARS OF EXPANDING YOUR HORIZONS IN SCIENCE AND MATHEMATICS IN TENNESSEE. ***Judith M. Iriarte-Gross, Sara Serati*, Rebecca C. Zijlstra, Jennifer Ilsley*, and Emma P. Zijlstra****, *Middle Tennessee State University, Murfreesboro, Tennessee.* Expanding Your Horizons in Science and Mathematics (EYH) is an international conference that began in 1976. The primary goal of EYH is to encourage young women, in grades 5–12, to take more math and science classes in preparation for college. Other goals of EYH are to increase the interest of young women in mathematics and science through positive hands-on experiences, to foster awareness of career opportunities in math and science related careers, to provide young women with opportunities to meet and interact with positive role models who are active in math and science related careers and to involve young women with limited opportunities for success in positive experiences in mathematics and science. Middle Tennessee State University (MTSU) has served over 3200 girls in Tennessee. We will describe our EYH conference and share comments from the girls who have benefited from the MTSU EYH experiences since 1997.

ZOOLOGY SECTION

GILBERT PITTS, CHAIR

FOOD HABITS OF THE COYOTE (*CANUS LATRANS*) IN WESTERN TENNESSEE. ***Jeremy S. Dennison* and Michael L. Kennedy***, *The University of Memphis, Memphis, Tennessee.* During 2007, the digestive tracts of 25 coyotes from western Tennessee were examined to determine food content. After collection, sex and age was determined, and digestive tracts were removed and frozen for later examination. Procedures for analyzing digestive tracts followed previous investigations conducted in the geographic region. Frequency of occurrence

was determined for food items and food types. Animal, vegetation, and miscellaneous foods were identified. Results are discussed in light of prior studies conducted in western Tennessee.

AN ASSESSMENT OF SPECIES RICHNESS AND HABITAT HETEROGENEITY OF SMALL MAMMALS IN COLIMA, MEXICO. ***J. Erin Fender and Michael L. Kennedy***, *The University of Memphis, Memphis, Tennessee.* In 2007, we examined the association of species richness and habitat heterogeneity of small mammals in Colima, Mexico. The study was conducted in tropical dry forest habitat near the City of Colima. A trapping grid with 100 trap stations, with adjacent stations located 10 m apart, was established. Two Sherman live traps were placed at each station, one on the ground (ground level) and one 1 to 2 m above the surface of the ground (arboreal level) on a thin plywood platform inserted within the vegetation. Traps were baited with rolled oats and checked daily for 8 days. Captured animals were identified as to species and tagged with Monel No. 1 ear tags and released at the site of capture. Structure of vegetation was quantified by evaluating 13 characteristics (% woody plants, % forbs, % grasses, % litter, % dead wood, % bare ground, number of shrubs hitting a l-m bar at 1-m height, % of canopy closed, slope, number of decimeter intervals in which vegetation touched a 7.5-m vertical pole, maximum height of canopy, and average distance to nearest tree) at points adjacent to each trap station. The association of species richness and habitat heterogeneity was examined using a Spearman rank correlation coefficient. Results reflected the occurrence of nine species on the study site. Associations of species richness and habitat heterogeneity are discussed in light of previous works.

PRELIMINARY OBSERVATIONS ON HABITAT PREFERENCE, MOVEMENT PATTERNS, AND SURVIVAL OF INTRODUCED JUVENILE ALLIGATOR SNAPPING TURTLES (*MACROCHELYS TEMMINCKII*). ***Joshua T. Ream* and A. Floyd Scott***, *Austin Peay State University, Clarksville, Tennessee.* We used mark-recapture and radiotelemetry to monitor non-native juvenile Alligator Snapping Turtles, *Macrochelys temminckii*, following release at the Wolf River Wildlife Management Area, Fayette County, Tennessee. Data were collected from May to August of 2007. The turtles exhibited non-random use of habitat, strongly associating with the water's edge, shallow depths, cover objects, moderately high canopy cover, and aquatic vegetation. Substantial movement occurred in the days immediately following release. Movements were more frequent during May and June than in July and August. After four months of study, one death was confirmed among the 74 individuals released. No adults or native individuals have been captured. Future efforts will involve continued trapping and radio tracking of previously released study animals plus additional radio tagged individuals to be released in spring 2008. Supported by the Tennessee Wildlife Resources Agency and Austin Peay State University's Center for Field Biology)

HABITAT USE AND SPATIAL DISPERSION OF EASTERN PIPISTRELLES, *PIPISTRELLUS SUBFLAVUS*, IN A HUMAN-IMPACTED CAVE SYSTEM. ***Riley Seth McCormick*, Sarah Jo Jenkins, Eric Johansen, Morgan Kurz, and Andrew N. Barrass***, *Austin Peay State University, Clarksville, Tennessee (RSM, EJ, MK, ANB) and University of Tennessee at Knoxville, Knoxville, Tennessee (SJJ).* Bat conservation relies heavily on knowledge of spatial distribution of species and habitat use among species. Information is lacking concerning the distribution of many bat species and there is little quantitative information on the behavior of species as they disperse. Furthermore, little data exists on large-scale spatial patterns of bat communities inside cave systems. Surveys of Dunbar Cave indicate high use within cave chambers not impacted by human activity. Bats were individually plotted by Geographic Information System and distances among individuals determined for analysis of spacing. Analysis of dispersion using the Morishita Index indicates the fragile population of Pipistrellus subflavus is slowly increasing. Habitat is constrained by varying levels of human interferences. Spatial arrangement of bats suggests avoidance of highly impacted cave chambers. Clumping patterns were identified in cave chambers. Results indicate that our novel methods are useful tools for resolving practical questions in behavioral ecology and restoration of cave roosting species.

A TWO YEAR STUDY OF OVER-WINTER SURVIVAL RATES OF TIMBER RATTLESNAKE, *CROTALUS HORRIDUS*, FROM AN ARTIFICIAL HIBERNACULUM. ***Danny L. Bryan***, *Cumberland University, Lebanon, Tennessee.* The Timber Rattlesnake, *Crotalus horridus*, is declining throughout much of its natural range. One possible contributing factor to this decline is the low over-wintering survival rates by young of the species. Several litters of timber rattlesnakes were placed in an artificial hibernaculum to determine over-wintering survival rates during a two year study. Minimum and maximum temperatures inside the structure were recorded from 22 December 2005 through 31 March 2006 and 11 November 2006 through 10 March 2007. Surviving snakes were counted and weighed on 02 April 2006 and 10 March 2007 respectively. Provided that young snakes locate adequate hibernacula, this study may indicate that over-wintering survival success may be relatively high in Middle Tennessee.

EFFECTS OF CONFINEMENT AND TEMPERATURE ON PLASMA LEVELS OF CORTICOSTERONE IN THE MIDLAND WATERSNAKE, *NERODIA SIPEDON PLEURALIS*, (COLUBRIDAE: NATRICINAE). ***Kyle L. Sykes and Matthew Klukowski***, *Middle Tennessee State University, Murfreesboro, Tennessee.* In vertebrates, the typical hormonal response to stress is characterized by an increase in plasma glucocorticoids but few studies have concentrated on stress in snakes. In 2005, 16 midland water snakes (*Nerodia sipedon pleuralis*) were caught and bled to determine baseline corticosterone levels, and, after one h of confinement, a second blood sample was taken to determine the effects of confinement on plasma corticosterone. Confinement resulted in an average five-fold increase in plasma corticosterone concentration. Baseline corticosterone concentration was positively correlated with both body mass and post-confinement corticosterone levels. In 2006, 30 *N. sipedon* were caught and subjected to a combined confinement and acute temperature stress (warmed, cooled, control). All groups exhibited robust corticosterone responses, but there was no effect of temperature treatment. However, females exhibited post-stress corticosterone levels approximately double those of males.

STEROL USAGE IN THE *SOLIDAGO* GALLING MIDGE *ASTEROMYIA CARBONIFERA* (DIPTERA: CECIDOMYII-

DAE): FUNGAL SYMBIONT AS A SOURCE OF STEROLS. ***Eric M. Janson* and Patrick Abbot***, *Vanderbilt University, Nashville, Tennessee*. Insects are unable to synthesize sterols and must therefore obtain them exclusively from their diet. To overcome this difficulty, many insects have formed symbiotic associations with microbes (especially fungi), which provision utilizable sterols. Here, we investigated if the fungal associate (*Botryosphaeria dothidea*) of the gall midge *Asteromyia carbonifera* acts as a sterol source for its host. CG-MS revealed that *B. dothidea*'s primary sterol was ergosterol, which is the primary sterol of most fungi. *A. carbonifera* tissues contained only ergosterol and ergosterol metabolites. *Solidago* had virtually no free sterols and instead most of its sterols were conjugated to other molecules. These results demonstrate that *B. dothidea* does provision utilizable sterols to *A. carbonifera*. The lack of free sterols in *Solidago* may present a significant nutritional barrier to phytophagous insects, and *A. carbonifera*'s phenomenal radiation on the genus may be in part due to the nutritional relationship with its fungal symbiont.

DNA-BASED ASSAYS REVEAL THE PRESENCE OF *BATRACHOHYTRIUM DENDROBATIDIS* IN THE GREAT SMOKY MOUNTAINS, A GLOBAL HOTSPOT OF AMPHIBIAN DIVERSITY. ***Jillian B. Kay*, Betsie B. Rothermel, and Chad S. Brooks***, *Austin Peay State University, Clarksville, Tennessee*. Chytridiomycosis is an exotic, infectious and fatal fungal disease of amphibians. Most notably, *Batrachochytrium dendrobatidis*, also known as Chytrid fungus, has been responsible for significant amphibian decline in 14 families and 96 species worldwide. Recently, Chytrid fungus has been detected in several regions of the eastern United States and is believed to be migrating westward into Tennessee. A preliminary survey was conducted to determine the prevalence of the Chytrid fungus within the Smoky Mountains. Approximately 300 tadpoles, metamorphs, and adult frogs were analyzed using polymerase chain reaction (PCR). PCR analysis revealed that several of the frogs were infected, indicating that the Chytrid fungus may be migrating westward and necessitating continued surveillance in surrounding areas.

REVIEW OF NOMENCLATURE AND COMMENTS ON THE GENUS *LEIOBUNUM* (ARACHNIDA: PHALANGIDA: SCLEROSOMATIDAE) OF NORTH AMERICA. ***Charles R. McGhee***, *Middle Tennessee State University, Murfreesboro, Tennessee*. In 1758 the genus Phalangium is established by Carl Linnaeus in the 10th edition Of *Svstema Naturae*. The order Phalangida is introduced by Latreille in 1802 with *Phalangium opilio* Linnaeus as the type species. In 1833 the ordinal name Opiliones (= Phalangida) is proposed by Sundevall. Numerous systematic revisions have occurred within the order for nearly 250 years. Homonyms and synonyms have been discovered by taxonomists who have attempted to sort an array of scientific names. Few type specimens are known. In 1839 C. L. Koch establishes the genus *Leiobunum* which presently contains about 115 described species worldwide. Approximately 37 described species occur in America north of Mexico. Thomas Say describes the first North American species of *Leiobunum* under the name *Phalangium vittatum* in 1821. The genus remains a difficult group of arachnids to comprehend, and continues to undergo revision. To date, 10 species of *Leiobunum* are known to occur in Tennessee.

HISTORY OF THE ZOOLOGY SECTION OF THE TENNESSEE ACADEMY OF SCIENCE, AN UPDATE, 1986 TO 2006. ***John R. Koons, John L. Butler, and James X. Corgan***, *Jackson State Community College, Jackson, Tennessee and Austin Peay State University, Clarksville, Tennessee*. In 1986, John L. Butler and James X. Corgan reviewed the history of the Tennessee Academy of Science (TAS) Zoology Section from its inception in 1944 to 1985. They divided the TAS Zoology Section presentations into six statistically distinct historical phases. This presentation is an attempt to bring that history up to the present (through the 2006 meeting), utilizing the same statistical analyses and comparing the first twenty years of the TAS Zoology Section with the last twenty years.

EXAMINING THE IMPACT OF HUMAN ACTIVITY ON SWAN LAKE. ***Jill A. Neblett* and A. Darlene Panvini***, *Belmont University, Nashville, Tennessee*. Swan Lake is a human-created lake located in Dunbar Cave State Natural Area in Clarksville, Tennessee. The lake is surrounded by various human-influenced habitats, such as a golf course and a road, and one side is bordered by the entrance to a cave. This study evaluated the overall water quality in the lake to determine if nearby human activities negatively impact the lake. Over the period of one month, eleven variables of water quality were measured each week on four sides of the lake. The results indicate that the overall water quality is good and that none of the human-influenced habitats appears to negatively affect overall quality. However, some of the individual variables (e.g. water temperature, pH, and turbidity) did appear to be influenced by the surrounding habitat. Information from this study can be used by the natural area staff in setting guidelines for managing the lake and surrounding property.

USE OF THE TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION "SAVE OUR STREAMS" SURVEY OF BIG MCADOO CREEK IN MONTGOMERY COUNTY, TENNESSEE. ***Yvette C. Eaton*, Regina Jordan* and Willodean D. S. Burton***, *Austin Peay State University, Clarksville, Tennessee*. Big McAdoo Creek is a natural scenic stream located in Montgomery County, Tennessee. Its unusual low flow during the 2007 summer prompted a concern for a comparison of present to previous conditions. Statistics from 1998 and 2004 surveys conducted by Tennessee Department of Environment and Conservation (TDEC), and The Environmental Protection Agency (EPA), indicated the water quality at Big McAdoo Creek was "fair". The standard "Save Our Streams" stream quality survey sheet was used for the assessment. A 3 by 3 meter plot in three different locations along the stream was measured in September 2007. The survey included macroinvertebrate counts which are the prime indicators for water quality, and a visual examination of the landscape around the stream. The 2007 assessment "Save Our Streams" survey over a portion of Big McAdoo Creek indicated a "good" to "excellent" water quality rating despite the dry summer conditions.

IMPACT OF ROAD CONSTRUCTION ON STREAM ECOLOGY IN STEWART COUNTY, TENNESSEE: A PRELIMINARY ASSESSMENT. ***Laurie J. Inglis* and Willodean D. S. Burton***, *Austin Peay State University, Clarksville, Tennessee*. Increases in the Tennessee population (6,038,803), an increase of 6.1% from 2000 to 2006 (United States, Census 2007) and escalation of vehicle miles traveled (up to 70,708 million miles

annually; TDOT, 2006) necessitates continual road construction. Small streams intersect numerous roads, requiring repair or addition to the 19,362 bridges in Tennessee (BTS, 2002). Two streams being bridged in conjunction with the expansion of State Route 79 between Clarksville and Dover were selected study sites. The objective was to apply Bioinfomatics in an environmental setting to determine construction effects on ecological systems. The null hypothesis was there would be no difference in the stream integrity parameters. The data included water quality, macroinvertebrate samples, and riparian environment and habitat assessments. Water quality remained stable for the initial four months; macroinvertebrate identification is incomplete; Geographic Information System mapping, using ArcGIS 9.2, provided visual interpretation of riparian environment and habitat assessments.

DISTRIBUTION OF AQUATIC COLEOPTERA IN CARROLL AND GIBSON COUNTIES, TENNESSEE. ***Jamie J. Miller* and Steven W. Hamilton***, *Austin Peay State University, Clarksville, Tennessee*. Ponds are unique wetland ecosystems that harbor various communities within their waters. The ten ponds sampled were located within three miles of each other in Carroll and Gibson counties in Western Tennessee. The ponds were sampled twice in two weeks using clear PVC funnel traps in 2006 and again in 2007. Jaccard's index was used to determine similarity between the genera of Coleoptera communities. The correlation of similarity between ponds ranged from 0 to 0.467 in 2006 and from 0 to 0.417 in 2007. In a yearly comparison, the ponds correlation ranged from 0 to 0.235. There was very little similarity between the pond communities in both years and a high variation in genera from year to year in pond communities. Even in close proximity, the ponds had diverse genera of Coleoptera and the genera present at any community were not constant during the sampled years.

HERPETOFAUNAL DIVERSITY AND ABUNDANCE AT CATTLE-ACCESS AND NON-CATTLE ACCESS PONDS AT THE MILAN ARMY AMMUNITION PLANT, GIBSON AND CARROLL COUNTIES, TENNESSEE. ***Benjamin J. Beas* and A. Floyd Scott***, *Austin Peay State University, Clarksville, Tennessee*. We assessed the herpetofauna in and around 18 fishless ponds, nine accessible to cattle and nine that were not accessible to compare the impacts of cattle on herpetofaunal diversity and abundance. Sampling techniques included minnow traps, cover objects and artificial refuges. The total number of individuals captured at the two pond types was statistically different, with non-cattle ponds exceeding cattle ponds. The average biomass per sample was statistically equal. The number of species and individuals found under the cover objects was highest at cattle ponds with *Diadophis punctatus* being the most abundant. Artificial refuges yielded only individuals of the *Hyla versicolor* complex with over two-and-a-half times more individuals than from the non-cattle ponds. Individuals captured at cattle ponds were significantly larger. Results suggest that: 1) amphibian density is greatest at non-cattle ponds, but biomass is similar overall; 2) abundance of terrestrial herpetofauna surrounding ponds is greatest where cattle are present; and 3) gray treefrog density is highest around ponds without cattle.

AQUATIC MACROINVERTEBRATE DIVERSITY IN NATURAL RIFFLE, ARTIFICIAL RIFFLE, AND POOL HABITATS FROM A NORTHWEST TENNESSEE STREAM. ***Tianita D. Duke* and Nancy L. Buschhaus***, *University of Tennessee, Martin, Martin, Tennessee*. Diversity of aquatic ecosystems can be impacted by habitat and temperature, especially in temperate streams that vary in the substrate available for macroinvertebrates. We used the Shannon-Weiner index to calculate the macroinvertebrate diversity between a natural riffle, artificial riffle, and the surrounding pools at a nearby creek, Spring Creek in McKenzie, Tennessee. In addition, we examined whether there was a correlation between temperature, depth, and the number of individuals captured. We captured 281 individuals of 29 different genera in these three habitats during our study. The pool habitat had the highest diversity while the natural riffle had the lowest diversity but the highest number of individuals. A correlation between temperature and the number of individuals was present along with a correlation between depth and the number of individuals.

RELATEDNESS AND INBREEDING IN EASTERN SUBTERRANEAN TERMINTE POPULATIONS AT MONTGOMERY BELL STATE PARK, DICKSON COUNTY, TENNESSEE. ***Ivey L Beck*, Steven Murphree, and Edward Vargo***, *Belmont University, Nashville, Tennessee*. Colonies of eastern subterranean termites, *Reticulotermes flavipes*, have been shown to possess a relatively high degree of inbreeding. In this study, we attempt to follow up on a previously published study that reported an unusually high degree of inbreeding at Montgomery Bell State Park in Burns, Tennessee. By using PCR and microsatellite techniques, we analyzed specimens collected from ten colonies. By comparing different loci within each colony, our preliminary data have revealed different conclusions than those previously reported. It is possible that there was a defect in the allozyme markers used in the previous investigation, or that there were newly founded colonies under genetic drift at the time of the previous research. The complete results of this study will be provided at the poster presentation.

PRELIMINARY RESULTS OF TREEFROG OCCUPANCY SURVEYS IN WESTERN KENTUCKY AND ADJACENT TENNESSEE. ***Lacey D. Robertson* and Betsie B. Rothermel***, *Austin Peay State University, Clarksville, Tennessee*. Our study will examine factors influencing the occurrence of hylid treefrog populations in agricultural wetlands of Kentucky and Tennessee. We will use calling surveys and Geographic Information Systems (GIS) to determine habitat associations of hylids, including barking treefrogs (*Hyla gratiosa*), a species of concern. In 2007, we randomly selected historical and recent *Hyla gratiosa* sites and established survey routes. During preliminary sampling, we surveyed 46 sites and detected 8 species of anurans, including *H. gratiosa* at 3 sites. In 2008, we will maximize the number of surveys per site, and use the computer program Presence to estimate *H. gratiosa* occupancy. We also will use landcover layers and aerial photos to compare landscape characteristics between occupied and currently unoccupied sites. These data will help document changes in *H. gratiosa* populations in Kentucky and Tennessee and provide insight into possible relations to landscape features.

USE OF TREETOP PEEPER™ TO INVESTIGATE CAVITY SUCCESSION IN A FRAGMENTED HABITAT. ***Cheryl L. Sesler* and H. Dawn Wilkins***, *University of Tennessee, Martin, Martin, Tennessee*. Cavities are a limited resource because few birds have the ability to excavate into trees. Fragmented habitats

tend to increase competition for cavities because edge habitats have a higher diversity of competitors and predators. Cavity succession refers to the progression of cavity use following a primary cavity user. To observe succession of cavity use, we used a TreeTop Peeper II system which consists of a fiberoptic camera mounted on a 15 m telescoping pole. We observed cavity succession in a cavity excavated by a Red-bellied Woodpecker (*Melanerpes carolinus*). The woodpeckers were usurped by European Starlings (*Sturnis vulgaris*) who were unsuccessful in their breeding attempt. The cavity was abandoned until a pair of Eastern Bluebirds (*Sialia sialis*) successfully nested in it. We will continue to monitor succession of cavity use and focus on determining if distance from the edge of a wooded area increases competition between animals for cavities.

THE EFFICACY OF SELECTED OVER-THE-COUNTER CHEMICAL REPELLENTS AGAINST *AEDES AEGYPTI* IN HUMAN VOLUNTEER LABORATORY ASSAYS. ***Cori O. Pedigo and Steve Murphree***, *Belmont University, Nashville, Tennessee*. Commercially available insect repellents can be divided into two categories: synthetic chemicals and plant-derived essential oils. The most effective synthetic chemical repellents include DEET, IR3535 and Picaridin. Efficacies of the commercially available repellents Repel® Sportsmen Formula® Insect Repellent, Repel® Insect Repellent, Skin so Soft® Bug Guard plus IR3535 and Skin so Soft® Bug Guard plus Picaridin were evaluated. Duration of protection by each product was tested with arm-in-cage studies, in which volunteers inserted their repellent-treated arms into a cage with a fixed number of unfed female *Aedes aegypti* mosquitoes, and the elapsed time to first landing/probing was recorded. The results of this study will be provided at the poster presentation.

THE EFFICACY OF SELECTED BOTANICALLY DERIVED BIOREPELLENTS AGAINST *AEDES AEGYPTI* IN HUMAN VOLUNTEER LABORATORY ASSAYS. ***Steve Murphree and Melissa J. Draper****, *Belmont University, Nashville, Tennessee*. Commercially available insect repellents can be divided into two categories: synthetic chemicals and plant-derived essential oils. The most effective natural plant-based repellents include oil of lemon eucalyptus, citronella oil, geranial oil, soybean oil, coconut oil, neem oil, and a combination of catnip and Osage orange. Efficacies of the commercially available repellents Buzz Away®, Bite Blocker®, Burt's Bees Insect Repellent® and Bug Band® were evaluated. Duration of protection by each product was tested with arm-in-cage studies in which volunteers inserted their repellent-treated arms into a cage with a fixed number of unfed female *Aedes aegypti* mosquitoes, and the elapsed time to first landing/probing was recorded. The results of this study will be provided at the poster presentation.

A NEW LOOK AT AN OLD QUESTION: COMBATING MOSQUITOES WITH NATURAL LARVICIDES. ***Habib Alradaei****, ***Christina Buckelew****, ***Megan Caudill****, ***Angella DeSisto****, ***J. Jeffrey Green, and Robert D. Tanner***, *Nashville State Technical Community College (HA, CB, MC, AD, JJG) and Vanderbilt University (RDT), Nashville, Tennessee*. Mosquitoes are vectors for diseases that kill over a million people annually. By eliminating adult mosquitoes the transmission of mosquito-borne illnesses should be reduced. Despite current methods used to combat mosquitoes at all life stages, incurred expenses and negative ecological impacts from the use of non-biodegradable chemicals, make many of these approaches less than ideal. Since mosquito larva are most prevalent in stagnate water, the development of larvicides offers ways to rapidly reduce mosquito numbers. This study focuses on the use of enzymes (amylase, bromelain, lipase, pepsin) as cost effective, natural larvicides that could be integrated into pest management programs minimizing environmental damage. Our results show these enzymes are effective in eliminating developing mosquito larvae while having no significant effect on plant growth. This suggests that incorporating active enzymes into an integrated pest management approach to mosquito prevention could be a safe alternative to using synthetic chemicals.

HATCHING CHRONOLOGY AND LARVAL GROWTH RATES OF THREE SPECIES OF AMBYSTOMATID SALAMANDERS IN NORTHWEST TENNESSEE. ***H. Brown****, ***S. Williamson****, ***and T. Blanchard***, *University of Tennessee, Martin, Martin, Tennessee*. Reproductive activity and timing of hatching is known to be geographically variable among populations of ambystomatid salamanders. However, few studies of the reproductive ecology of this group have been conducted in northwest Tennessee. We determined timing of oviposition and hatching in three species of salamanders at three locations within the Obion River Wildlife Management Area. Known breeding ponds were frequently surveyed visually for egg masses and aquatic dip-nets were used to document the presence of newly hatched larvae. Additionally we calculated growth rates in *Ambystoma opacum* by making weekly measurements of the total length of 10–20 individuals from each of the three locations.