ABSTRACTS OF PAPERS PRESENTED AT THE 109TH ANNUAL MEETING

BOTANY SECTION

KENT GALLAHER, CHAIR

FOREST COMPOSITION AND COMMUNITIES OF A WESTERN HIGHLAND RIM FOREST, HICKMAN COUNTY, TENNESSEE. ***Rex Barber,*** *Volunteer State Community College, Gallatin, Tennessee.* The Point-quarter plotless sampling technique was utilized for a dendrological survey of a western Highland Rim, Hickman County, Tennessee forest. This 405 ha forest apparently has not been influenced by point disturbances for a century or more. Forest communities were analyzed and documented utilizing Importance Value statistics. Statistical data from the entire forest survey shows a *Quercus alba-Q. prinus-Oxydendrum arboreum* community. Survey data further shows a *Q. alba-Q. stellata-Q. prinus* community on the ridges, a *Q. alba-Carya tomentosa-Liriodendron tulipfera* community in the hollows and footslopes, a *Q. alba-Q. arboreum-Q. falcata* community on the xeric slopes, and a *Q. alba-Q. prinus-C. tomentosa* community on the mesic slopes. In a separate study, the riparian land was dominated by a *Platanus occidentalis-Acer saccharum-Liquidambar styraciflua* community. Physiography, climate, edaphic conditions, vegetational settings, and the history of this forest are discussed. Herbaceous plants collected, ages of several trees, and visual observations also are reported.

ASSESSING PHOTOSYNTHETIC POTENTIAL IN A HOLOPARASITIC PLANT WITH A CONSERVED PHOTOSYNTHETIC GENE. ***Carol J. Baskauf, W. G. Eickmeier, and C. W. dePamphilis,*** *Austin Peay State University, Clarksville, Tennessee, Vanderbilt University, Nashville, Tennessee, and Pennsylvania State University, University Park, Pennsylvania.* We compare in vivo gas-exchange data and in vitro RUBISCO activity for a holoparasite (*Orobanche corymbosa*), a hemiparasite (*Pedicularis canadensis*), and a nonparasite (*Antirrhinum majus*) in the family Scrophulariaceae. Unlike hemiparasites, holoparasites appear to lack chlorophyll and depend entirely on their hosts for nutritional carbon. Freed from evolutionary constraints, photosynthetic genes (such as rbcL, coding for the large subunit of RUBISCO) have mutated freely or even been eliminated in some holoparasitic lineages. Surprisingly, the holoparasitic *O. corymbosa* maintains an apparently functional rbcL gene, with statistical analysis suggesting that the open reading frame (ORF) is being retained because of functional constraint rather than chance. Nonetheless, our study provides no evidence of in vitro RUSISCO activity or net photosynthetic CO_2 uptake in the light for *O. corymbosa.* Similar levels of CO_2 evolution occur under light and dark conditions. In contrast, photosynthetic activity is evident for both *Antirrhinum* and *Pedicularis,* with levels of CO_2 uptake in the light and RUBISCO activity appearing to be higher for the nonparasite than for the hemiparasite. Evolutionary and functional evidence suggests that rbcL may encode a protein with an unexpected nonphotosynthetic function in *O. corymbosa.*

EXAMINATION OF DROUGHT TOLERANT GENES IN *GLYCINE MAX.* ***Yunru Cao*, D. Long, C. Caudle, and E. Lewis Myles,*** *Tennessee State University, Nashville, Tennessee.* Soybeans are a very economically important legume crop grown in the Americas. Drought stress imposes a significant constraint on crop production in the world today. In this study, Polyethylene Glycol (PEG) 10,000 was used to simulate drought conditions in vitro. Three cultivars were studied, Hutchenson, York, and Ware. The total weight and length of seedlings were recorded at the end of a 7-day exposure period to 0% (control), 2%, and 4% PEG solution. Hypocotyls and roots were excised to study gene expression. Hutchenson was the most drought-tolerant and Ware was the most sensitive to the simulated drought conditions. The technique of Differential Display was used to examine gene expression in both tolerant and sensitive cultivars. The hypocotyl showed more DNA agarose bands than hypocotyl groups under drought stress. Hypocotyls exposed to 4% PEG only had a band that was 2,153 base pairs (bp), but the control group had two bands that were 780 bp and 728 bp. In roots, several different bands were observed in 0% (control) and 4% PEG group. The bands in the control group were 1389 bp, 946 bp, and 506 bp. The bands in the 4% PEG were 2027 bp, 1333 bp, 799 bp, 517 bp, and 423 bp. These results indicate that possibly the genes containing the sequences of 1389 bp, 946 bp, and 506 bp were turned off, while genes containing the sequences of 2027 bp, 1333 bp, 799 bp, 517 bp, and 423 bp were turned on in response to the drought stress. Further experiments should be performed to determine if the latter sequences are portions of drought tolerant genes. These sequences can be used as probes to screen a soybean cDNA library.

WESTERN BLOT ANALYSIS OF DROUGHT TOLERANCE IN SOYBEANS. ***Shana Benton*, D. Long, C. Caudle, and E. Lewis Myles,*** *Tennessee State University, Nashville, Tennessee.* Stress in any organism can be described as any change in environmental conditions that might reduce or adversely change an organism's growth or development. Drought is one of many environmental stresses that crop plants may encounter. Prolonged periods without water can severely reduce crop vigor, and ultimately reduce crop yield. This reduction in yield is often transferred to the consumer as higher prices. Our lab is screening soybeans for drought tolerance. The cultivars used in the study are Forrest and Hutcheson. The plants grew in 0.0, 0.4 and 0.8% NaCl for seven days. At the end of the seven-day exposure period, the total length, root length, and root weight were recorded. The analysis of the results by ANOVA identified the salt tolerant cultivar. In comparing cultivars Forrest and Hutcheson, we found that Hutcheson was more tolerant than Forrest. One dimensional gel electrophoresis and Western Blots were used to identify specific proteins synthesized in either the sensitive or tolerant cultivars.

THE EFFECTS OF SHADING AND NUTRIENTS ON RE-

SOURCE ALLOCATION IN AN EXOTIC INVASIVE, *MICROSTEGIUM VIMINEUM*. ***Kevin Claridge* and Scott B. Franklin,*** *The University of Memphis, Memphis, Tennessee.* The invasion of alien species into natural ecosystems has been shown to negatively affect species diversity and ecosystem function. A framework for predicting the invasibility of an area and the capability of an alien plant to spread in natural systems is necessary for determining the magnitude and nature of environmental impact. *Microstegium vimineum* (Trin.) A. Camus is an invasive exotic grass that is colonizing numerous habitats because of its tolerance to various light and nutrient resources. It was hypothesized that this alien species may compensate for low light levels by spreading into nutrient rich soil, which is typical for its floodplain habitat. This grass also was thought to accelerate stolon production or vegetative biomass to increase spread in low light conditions, rather than expending energy on sexual reproductive bodies. The plasticity of the plant modules involved in spread and the resource allocation of *M. vimineum* was examined under different light and nutrient levels using a balanced field and greenhouse study. The results from this experiment show that shading alters resource allocation patterns, but does not limit the overall invasibility due to the plastic use of the available resources. Plants grown in nutrient stressed environments greatly reduced reproductive spread. Conversely, altering the amount of available light for plants did not moderate distribution. *M. vimineum* seems to be taking advantage of an unutilized nutrient resource under the canopy to continue plant spread success. Investigations of resource drift within invasive exotic plants allow ecologists to govern and forecast both the present and future effects of these plants.

PLANT AND SOIL NUTRIENT ANALYSIS OF *CHAMAELIRIUM LUTEUM* AND *HYDRASTIS CANADENSIS* WILDCRAFTED FROM A SOUTHERN HIGHLAND RIM HARDWOOD FOREST. ***Kent Gallaher and R. Noel Gallaher,*** *Lipscomb University, Nashville, Tennessee, and The University of Florida, Gainesville, Florida.* Many wild plants are increasingly being used for medicinal purposes. As wild populations of these plants decline, domestication seems inevitable. Soil fertility and nutrient sufficiency data will be critical for viable commercial production of theses plants. Nutrient analysis of diagnostic tissues from *Chamaelirium luteum* and *Hydrastis canadensis* was performed. Soil type and fertility analysis was conducted on soils from wild growing sites for each plant. *C. luteum* was found to grow on upper slopes with little ground cover. *H. canadensis* was found to grow in bottoms of hollows. Soils from all sites were classified as loams, were relatively rich in organic matter, and all plant nutrients with the exception of site P *H. canadensis* had pH that was near neutral (6.8) while *C. luteum* sites were acidic (4.5). Leaf tissue analysis for *H. Canadensis* was 27.4, 3.6, 30.1 g/kg for sites N, P, and K respectively. Leaf tissue analysis for *C. luteum* was 12.3, 1.1, 12.4 g/kg for the same nutrients.

CHLOROPHYLL DEFICIENCY IN INDIAN MUSTARD (*BRASSICA JUNCEA*): AN ASSESSMENT OF PLANT TOLERANCE TO METAL POLLUTANTS IN SOIL. ***M. S. Zaman*, K. L. Shumaker, L. Johnson, and A. M. Powell,*** *Alcorn State University, Alcorn State, Mississippi.* Phytoremediation, a green technology, uses vegetation to remove heavy metals or other pollutants from the environment. Phytoremediation depends upon identifying plant species that can tolerate and accumulate high concentrations of these pollutants. The purpose of this study was to investigate the tolerance of *Brassica juncea* to various concentrations of cadmium (Cd) and lead (Pb) in soils. Plants were grown on soils containing various concentrations of Cd and Pb. Since chlorophyll is related to plant production, we studied the leaf chlorophyll concentrations on days 14 and 21 of plant life. On both days, dose related inhibition of chlorophyll *a,* chlorophyll *b,* and total chlorophyll concentrations were observed in several Cd and Pb treated groups. Since this plant species showed tolerance to high concentrations of Cd and Pb in soils, it may be useful for phytoremediation studies. Investigations are being conducted in our laboratory to explore the hyperaccumulation potential of *B. juncea* for soil Cd and Pb.

CHARACTERISTICS OF PHOTOAUTOTROPHIC PERIPHYTON WITHIN THE SULPHUR FORK CREEK WATERSHED OF ROBERTSON COUNTY, TENNESSEE. ***Rebecca A. Houtman* and Jefferson G. Lebkuecher,*** *Austin Peay State University, Clarksville, Tennessee.* Effects of water quality in the Sulphur Fork Creek Watershed and Big Buzzard Creek of Robertson County, Tennessee, on primary production and photoautotrophic-heterotrophic relationships were evaluated during the spring, summer, and fall of 1998. Overall, Big Buzzard Creek had low primary production and heterotrophic biomass to photoautotrophic biomass ratios, both suggestive of good water quality relative to stream sites within the Sulphur Fork Creek Watershed. Previous determinations of Photosystem-II concentration, Photosystem-II photochemical efficiency, and reproduction rate following in situ growth of the pollution-intolerant alga *Selenastrum capricornutum* at the same stream sites support conclusions from the periphyton characteristics data, which indicate poor water quality within the Sulphur Fork Creek watershed relative to Big Buzzard Creek.

CELL AND MOLECULAR BIOLOGY/MEDICAL SCIENCE SECTION

HAO NGUYEN, CHAIR, AND DAVID O'DROBINAK, CHAIR

TADPOLE ERYTHROCYTE FERRIREDUCTASE: AN ENZYME THAT RELEASES STORED IRON. ***Charles R. Thomas,*** *The University of Tennessee, Martin, Martin, Tennessee.* An activity that releases ferritin-bound iron was observed in tadpole red blood cells. This ferrireductase (FRED) activity uses NADH for reducing power, and FMN as the electron carrier to iron. FRED of high purity was obtained after three chromatographic steps. Most of the protein and nearly all the hemoglobin binds to CM-Sephadex, but FRED does not. Application of the eluate to Bio-Rad HiQ ion exchange gel (pH 8.1) and elution with a NaCl gradient separates FRED into three broad peaks. Passage in reverse order over dodecyl agarose removes nearly all of the remaining protein, but the FRED elutes almost unretarded. Native PAGE shows few bands, but it is not clear if these represent FRED. SDS-PAGE shows a similar group of bands in the FRED-containing fractions from all three areas of the HiQ chromatogram. It is not certain that these are FRED or, if they are, why they separate on HiQ.

STRUCTURAL ANALYSIS OF GLYCERALDEHYDE 3-PHOSPHATE DEHYDROGENASE FROM *ESCHERICHIA*

COLI: DIRECT EVIDENCE FOR SUBSTRATE BINDING. ***Mikyung Yun, Cheon-Gil Park, J. I. Yeon Kim, and Hee-Won Park,*** *St. Jude Children's Research Hospital, Memphis, Tennessee.* The crystal structure of Gyceraldehyde-3-Phosphate (GAPDH) from *Escherichia coli* has been determined in various ligand states (ligand-free, NAD^+-bound, and GAP-bound). The ligand-free structures reported here are in two different crystal forms, monoclinic and tetragonal systems. Conformational change in GAPDH induced by NAD^+ binding is very small and is limited to the residues involved in binding of the adenine moiety. The phosphate moiety of substrate GAP binds in a hydrophilic pocket, called the "Pi" site. The observed location of the GAP phosphate moiety is consistent with the flip-flop model for GAP binding, where the phosphate moiety of GAP initially bound at the "Pi" site flips to the "ps" site after hydride transfer during the cofactor exchange step. The superposition between NAD^+-bound and GAP-bound structures reveals an interaction of the hydroxyl oxygen at the hemithioacetal carbon C1 of GAP with the nicotinamide ring, suggesting the cofactor NAD^+ as the transition state stabilizer for forming the hemithioacetal intermediate.

EXOSOME PROTEINS MAY BE INVOLVED IN SNRNA BIOGENESIS. ***Rebecca L. Seipelt, Brian C. Rymond, and T. H. Morgan,*** *Middle Tennessee State University, Murfreesboro, Tennessee (RLS), and University of Kentucky, Lexington, Kentucky (BCR, THM).* A group of unusual RNAs, small nuclear ribonucleic acids (snRNAs), is required for eukaryotic cell life by virtue of the activity within a larger complex called the spliceosome. The spliceosome subunits interact with premature messenger RNA to produce mature messenger RNA. Premature forms of snRNAs have been identified, are lengthened at their 3′ ends, and must be processed to the mature, active forms. One directly interacting protein, RNase III, has been identified. Another set of proteins that may be involved are exosome proteins, enzymes found as a unit that cleave RNA molecules from the 3′ to the 5′ end. This directionality is unusual and is the activity required to "chew back" precursor snRNAs to the mature end. Depletion of individual exosome proteins allowed lengthened (premature) U4 and U5 snRNAs to be formed. This indicates the exosome proteins are involved, directly or indirectly. Direct interaction will be tested using a three-hybrid system.

EWS-INTERACTING PROTEINS. ***Lori L. Knoop* and Suzanne J. Baker,*** *St. Jude Children's Research Hospital, Memphis, Tennessee, and The University of Tennessee, Memphis, Memphis, Tennessee.* As a result of the t(11;22) chromosomal translocation characterizing the Ewing family of tumors, the amino terminal portion of EWS, an RNA-binding protein of unknown function, is fused to the DNA-binding domain of one of the five members of the ets transcription factor family, most commonly FLI-1. Fusion proteins containing the same N-terminal portion of EWS also are created by translocations in several other tumor types. The involvement of this region of EWS in so many tumors suggests that it plays a critical role in tumorigenesis. Employing the yeast-2-hybrid system, we found that EWS and EWS/FLI interact with multiple, splicing factors. Our results suggest that EWS and EWS/FLI may be involved in the splicing pathway, and that disruption of normal interactions in this pathway may lead to tumorigenesis.

ACTIVATION OF TRANSCRIPTION BY INTERFERON REGULATORY FACTOR IS DETERMINED BY PROMOTER CONTEXT. ***Michelle M. Crum, Paul W. Rhyne, and Jeffery Sample,*** *St. Jude Children's Research Hospital, Memphis, Tennessee, and The University of Tennessee, Memphis, Memphis, Tennessee.* Interferon Regulatory Factor-2 (IRF-2) is a transcription factor initially characterized as a transcriptional repressor. We have shown that IRF-2 activates the Epstein-Barr virus (EBV) EBNA-1promoter Qp. EBNA-1 expression is essential for long-term maintenance of the EBV genome in infected B lymphocytes. Therefore understanding the regulation of EBNA is vital to deciphering the biology of EBV and its oncogenic potential. The objective of this study was to understand the mechanism of IRF-2 mediated activation. Our DNA-binding studies indicate that promoter context (number of IRF-2 binding sites) differs between IRF-2 activated and repressed genes. Furthermore, transfection results show that promoters containing one IRF-2 binding site activate transcription while those promoters with two IRF-2 binding sites repress transcription.

MAJOR HISTOCOMPATIBILITY COMPLEX CLASS II ALLELES IN RHEUMATOID ARTHRITIS. ***Kary Latham* and Edward Roslopiec,*** *The University of Tennessee, Memphis, Memphis, Tennessee, and Veterans Administration Medical Center, Memphis, Tennessee.* Numerous studies have illuminated an association between the incidence of rheumatoid arthritis and the expression of particular Major Histocompatibility Complex (MHC) class II genes. The HLA-DR4 and HLA-DR1 MHC class II alleles specifically are found in the majority of individuals presenting with this disease. To better examine the mechanisms behind this phenomenon, transgenic mice were created that express the human DR4 gene (DRB1*0401) and are susceptible to autoimmune arthritis induced by type II collagen, a major component of articular cartilage. With the aid of these mice, we have begun to map the course of this disease and to examine the role that various cytokines play in its progression.

VANCOMYCIN TOLERANCE IN *STREPTOCOCCUS PNEUMONIAE.* ***Robyn Atkinson* and Rodger Novak,*** *The University of Tennessee, Memphis, Memphis, Tennessee, and St. Jude Children's Research Hospital, Memphis, Tennessee.* Tolerant bacteria stop growing in the presence of an antibiotic yet they fail to die. Vancomycin is the antibiotic of last resort for many bacterial infections, and resistance to vancomycin is an emerging threat. A cluster of genes in the *Streptococcus pneumoniae* genome has recently been associated with vancomycin tolerance in this community-acquired species. This region encodes a putative two-component regulatory system, VncR, and VncS, that senses and processes signals from the outside to cause changes in gene expression. The area of interest also encodes a putative ABC-transporter and a 27 amino acid peptide. A model for the mechanism of this system hypothesizes that the peptide is secreted into the supernatant via the ABC-transporter. Once the peptide reaches a critical density in stationery growth phase, it is sensed by VncS, which acts as a phosphatase to dephosphorylate the response regulator, VncR. This dephosphorylation relieves repression, allowing genes in a death pathway to be transcribed, leading to lysis of the bacteria. Insertion mutagenesis of the VncS gene produces a tolerant phenotype in the laboratory strain R6. The mutant was tolerant to penicillin, vancomycin, and several other classes of antibiotic. This indicates that antibiotics require signal transduction to achieve bacterial killing. To date, only one clinical isolate

of *S. pneumoniae* has been found to harbor a mutation in the VncS gene.

DYNAMICS OF T-CELL RECEPTOR: CD3 COMPLEX CELL SURFACE EXPRESSION AND DOWN MODULATION. ***Haiyan Liu*, Dario A. Vignal, Michele Rhodes, and David Wiest,*** *The University of Tennessee, Memphis, Memphis, Tennessee (HL), St. Jude Children's Research Hospital, Memphis, Tennessee (DAV), and Fox Chase Cancer Center, Philadelphia, Pennsylvania (MH, DW).* T Cell Receptor (TCR) recognition of immunogenic peptides bound to major histocompatibility complex (MHC) molecules leads to T cell activation and a variety of effector functions. A key event in this process is TCR down-modulation, which may facilitate the serial ligation of many TCR by a few MHC:peptide complexes. However, the mechanism of TCR down-modulation remains elusive. Here we investigated the dynamics of TCR:CD3 cell surface biotinylation. We have shown that the TCR:CD3 complex is rapidly recycling on resting T cells. Surprisingly, the rate of internalization was not significantly increased following TCR ligation under physiological conditions. Thus, most of the TCR on antigen stimulated T cells is internalized for recycling, rather than as a consequence of ligation by MHC:peptide complexes. TCR down-modulation is primarily mediated by intracellular retention of ligated complexes, which are redirected for degradation.

EXPRESSION OF CYCLOOXYGENASE-1 AND -2 AND PROSTAGLANDIN E2 DURING POSTNATAL DEVELOPMENT OF RAT COLON. ***Hao Nguyen, Nadine Romain, Mark S. Gesell, and Gordon D. Luk,*** *The University of Tennessee, Martin, Martin, Tennessee (HN), Presbyterian Hospital IEEM/ Neuromuscular Center, Dallas, Texas (NR), Veterans Affairs Medical Center, Dallas, Texas (MSG), and Digestive Health Associates of Texas, Euless, Texas (GDL).* Cyclooxygenase-1 and -2 (COX-1 and COX-2) have been implicated in cell proliferation and differentiation. The aim of this study was to measure the expression of COX-1 and COX-2 proteins and their relative activities as indicated by the amounts of PGE_2 in rat colonic mucosa during early stages of postnatal development. Immunohistochemistry was used to assess the amounts of COX-1 and COX-2 proteins and PGE_2 in rat colon on days 1, 7, 14, 21, and 28, after birth, and in adults. COX-1 and COX-2 proteins and PGE_2 were present at very low levels in the colon on day 1. Each increased to maximum levels by day 14 in both the proximal and distal colons, then decreased and remained at low levels until day 28. These levels were slightly increased again in adult rat colons. These results indicate that COX-1, COX-2, and PGE_2 are expressed in postnatal rat colons. The dynamic changes in the levels of expression during the first two weeks after birth suggest they may play a role in cell proliferation, and possibly cell differentiation, during early postnatal development of the rat colon. Furthermore, they also may play a role in cell proliferation in the colonic mucosa of adult rats.

THE EFFECTS OF DIET ON VOLATILE FATTY ACID CONCENTRATIONS IN THE STOMACH OF THE HORSE: IMPLICATIONS IN GASTRIC ULCER DISEASE. ***Jenifer Nadeau*, Frank Andrews, James Blackford, Alan Mathew, and Robert Argenzio,*** *The University of Tennessee, Knoxville, Knoxville, Tennessee (JN, FA, JB, AM), and North Carolina State University, Raleigh, North Carolina (RA).* Volatile fatty acids (VFAs) have been implicated in acid injury and gastric ulceration in porcine gastroesophageal mucosa and may contribute to acid injury and gastric ulceration in equine non-glandular squamous mucosa. Gastric juice pH, VFAs, and number and severity of gastric lesions were evaluated in six 7-year-old horses with gastric cannulas fed different diets. Horses were randomly assigned a bromegrass hay diet or an alfalfa hay/grain diet in a two-week period crossover design. Gastric juice was collected immediately postfeeding and 1–8, 10, 12 and 24 h after feeding, while the horses fasted. Horses underwent gastroscopy before beginning each diet and after the 24 h fast on day 15. Gastric juice pH was measured using a pH electrode. Concentrations of VFAs (acetic, propionic, and isovaleric acids) were measured using gas chromatography. Number and severity of gastric lesions were scored by gastroscopic examination. The pH of the gastric contents was variable throughout the 24 h collection period. The alfalfa hay/grain diet produced significantly higher pH, acetic, propionic and isovaleric acid concentrations when compared to the bromegrass hay diet. Non-glandular gastric lesion number and severity scores were significantly lower in horses fed the alfalfa hay/grain diet when compared to the horses fed the bromegrass hay diet. Alfalfa hay, due to its high protein and calcium concentrations, may act as a dietary antacid. Alfalfa hay may have a protective effect on the non-glandular gastric mucosa in horses.

SOLEUS MUSCLE POTENTIATION IN RAT SKELETAL MUSCLE. ***Angela K. Vaughn*, Molly J. Worrall, David M. O'Drobinak, and William F. Brechue,*** *Austin Peay State University, Clarksville, Tennessee (AKV, MJW, DMO), and Indiana University, Bloomington, Indiana (WFB).* Previously we observed that following 30 min of repetitive isometric contractions, recovery of maximal isometric tension (Po) was significantly greater in the rat gastrocnemius-plantaris-soleus (GPS) complex than that observed in the gastrocnemius-plantar (GP) complex after 30 min of recovery. We hypothesized that the delayed recovery in the GPS group was due to an increased fatigue of the soleus muscle due to the supramaximal stimulation frequency used in these experiments. In the present study, the mechanical response to, and recovery from, repetitive contractions (RC) was studied in the isolated rat soleus, in situ. The isolated rat soleus muscle was stimulated to elicit repetitive isometric contractions for 30 min at 1/sec with 220 msec trains at 100 imp/sec. Following RC, mechanical recovery was assessed using single twitch and tetanic contractions at five and 30 sec, and 1, 5 and 30 min. During RC, Po decreased 16% (from 1480 ± 129 to 1355 ± 125 g/g) following RC. Interestingly, Po "recovered" to 121% of initial (1794 ± 130 g/g) at 5 min post-RC and then declined to the initial tension (1468 ± 148 g/g) at 30 min post-RC. Although the soleus initially potentiates Po following RC, it begins to decrease its recovery tension by 30 min. Thus, the soleus presents an intriguing "recovery" pattern from RC, which apparently explains its role in delaying recovery Po of the GPS complex following RC.

METHYLPREDNISOLONE PHARMACOKINETICS IN PATIENTS WITH ACUTE RESPIRATORY DISTRESS SYNDROME. ***Charles R. Yates*, Alexander Vysokonov, Umberto Meduri, and James T. Dalton,*** *The University of Tennessee, Memphis, Memphis, Tennessee.* Acute respiratory distress syndrome (ARDS) results in > 50% mortality despite therapeutic intervention. Trials employing short duration (< 24 h) methylprednisolone failed to reduce mortality. Goals of this trial were to: 1) determine the effect of prolonged administration (> 24 h)

of methylprednisolone on mortality, and 2) determine if non-responders exhibit altered pharmacokinetics. Methods: HPLC was used to determine methylprednisolone plasma concentration in 20 ARDS patients. The non-linear regression program NONMEM was used to generate population estimates of methylprednisolone volume of distribution and clearance (removal of drug). Results: Clearance was lower and volume higher in patients compared to healthy individuals. Survivors (17/20) demonstrate a time-dependent increase in clearance. Non-survivors' (2/3) clearance continued to deteriorate during therapy. Discussion: Data indicate clearance is inversely related to the acute phase response (as the inflammatory process resolves individual clearance improves). Our goal is to use time-dependent changes in clearance to determine individual response to methylprednisolone therapy.

STAT ACTIVATION IN SCHWANN CELLS BY INJURY SIGNALS. ***Jessica C. Hogan and William C. Stewart,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Schwann cells are associated with the axons of peripheral nerves and have an important role in the regeneration of axons following nerve injury. We investigated the expression of Signal Transducers and Activators of Transcription (STATs) in the Schwann cell line, RN22. STATs are a ubiquitous family of proteins that have been shown to be a major component of intracellular signaling in diverse cell types. STATs are activated by phosphorylation whereby they translocate to the nucleus to regulate tissue specific gene expression. Western blot analysis revealed that RN22 cells express Stats 3, 5A, and 6 and that Stat 1 and Stat 4 were absent. RN22 cells also were analyzed for STAT activation. We found that Stat 3 was phosphorylated by IL-1, IL-6, LIF, and OSM, cytokines associated with the gp-130 signaling pathway. Both IL-1 and IL-6 have a prominent role in the signal of nerve injury in the nervous system, suggesting a role of STATs in neural tissue repair.

EVALUATION OF CAPILLARY ZONE ELECTROPHORESIS IN DETECTING MONOLCONAL GAMMOPATHIES. ***D. L. Smalley*, M. F. Bugg, and R. P. Mayer,*** *The University of Tennessee, Memphis, Memphis Tennessee (DLS), Memphis Pathology Laboratory, Memphis, Tennessee (RPM), and Pathology Group of the MidSouth, Memphis, Tennessee (MFB).* Capillary zone electrophoresis (CZE) has become a commonly used method to evaluate human serum proteins using a narrow-bore silica capillary. The proteins are separated by differences in their electrophoretic mobility, which allows the detection of monoclonal gammopathies. A total of 55 consecutive protein electrophoreses were performed by CZE with non-definitive abnormal proteins. These abnormal proteins were assessed for estimate of concentration, for monoclonality, and for classification. In addition, 40 consecutive protein studies with definitive monoclonal proteins were tested. Assessment was similar to that previously described. Among the 26 cases with follow up, 11 had no monoclonality. The remaining 15 showed that IgG was the dominant class and 8 of the 15 had concentrations between 100 and 500 mg/dl. Two sera had confirmed monoclonals at 50 mg/dl. Among the 40 definitive cases, 13 had no follow up. Seven cases had no monoclonality. Nineteen of the 27 cases were IgG and concentrations varied from < 1.0 to > 2.0 g/dl. In summary, the non-definitive abnormal proteins were confirmed in 15 of 26 cases (57.7%) with detection as low as 50 mg/dl. Definitive monoclonals were confirmed in 20 of 27 cases (74.1%) with various concentrations.

CHEMISTRY SECTION

DANIEL SWARTLING, CHAIR

OPTIMIZATION OF THE SYNTHESIS OF GUERBET ALCOHOLS. ***Carrie Teague, Sarah Shaub, Catherine Scarbrough, and Charles M. Baldwin,*** *Union University, Jackson, Tennessee.* The synthesis of a Guerbet alcohol from a long chain primary alcohol was studied. The reaction is catalyzed by a strong base and a transition metal oxide co-catalyst. The progress of the reaction was monitored by gas chromatography and the rate of water production. The formation of Guerbet alcohols from several related decanols was investigated. Particular attention was focused on product yield, product purity, and the reaction kinetics. Reaction products were characterized by IR and NMR spectroscopy, as well as wet chemistry methods.

THERMAL DECOMPOSITION OF ACETONE TRIMERS DURING GC-MS ANALYSIS. ***Martin V. Stewart and Xiaoming Wang,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Triacetone alcohol and semiphorone undergo retrograde aldol reaction catalyzed by carbonaceous residues adhering to the surface of the injector port of the gas chromatograph during GC-MS analysis. A clean glass liner in the injector port is helpful in preventing thermal decomposition, but this improvement does not last very long. When the injector port temperature is lowered to 80°C, no retrograde aldol products are observed, and molar response factors towards the mass selective detector for diverse aldol condensation products of acetone are directly proportional to their molar masses.

STRUCTURAL STUDIES OF CYCLIN-DEPENDENT KINASE INHIBITORS: DYNAMICS AND FLEXIBILITY ARE THE STORY. ***Richard W. Kriwacki, Igor Filippov, Ruchi Khanna, Chester Veazie, and Limin Xiao,*** *St. Jude Children's Research Hospital, Memphis, Tennessee.* p21Waf1/Cip1 is an inhibitor of cyclin-dependent kinases involved in regulation of cell division and was the founding member of a family of functionally related kinase inhibitors (cyclin-dependent kinase inhibitors; CKIs), now known to include p27, p28, p57, and DACAPO. These inhibitors play important roles in mediating cell growth arrest in response to a wide variety of biological stimuli, and as a family, may constitute the most important growth arrest mechanism in eukaryotic cells. In terms of the fundamental mechanisms governing the formation of protein assemblies, the CKIs are particularly interesting because they undergo a disorder-to-order transition on binding their targets. New insights into CKI structure/function relationships have emerged recently through detailed NMR analyses of several CKIs. These results and their biological implications will be discussed.

COMPUTER APPLICATIONS IN ENVIRONMENTAL CHEMISTRY: A PROCEDURE FOR COMPARING PETROLEUM HYDROCARBON SAMPLES. ***David J. Wilson and Robert D. Norris,*** *Eckenfelder/Brown and Caldwell, Nashville, Tennessee.* Distinguishing between different sources of hydrocarbon mixtures in environmental samples is complicated by local variations (in space and time) of the compositions of these mixtures and by uncertainties in the laboratory analyses. Information regarding the source(s) may be important in the assessment of contaminated sites, in the design of remediation systems, and in litigation. A method is presented which utilizes lumped composition data

(Paraffins, Isoparaffins, Aromatics, Naphthenes, and Olefins–PIANO) to calculate generalized distances between samples in a five-dimensional PIANO space. Results are generated from data from a contaminated aquifer. The results are analyzed statistically and appear to provide a convincing method for discriminating between sources. Further work will be needed to validate this approach.

THE SYNTHETIC APPROACH TO D-ALA-D-ALA PEPTIDOMIMETICS, A NEW CLASS OF POTENTIAL ANTIBACTERIALS. ***N. K. Dunlap, Garry D. Pennycuff*, and Tao Meng****, *Middle Tennessee State University, Murfreesboro, Tennessee.* In the past few years the newsmedia and Internet have been flooded with details of new "Superbugs" being added to the already vast number of drug-resistant bacteria. Whether this is a result of doctors over-prescribing antibiotics or consumer misuse of traditional drugs, it has been apparent for quite some time that new antibacterial agents are needed. Our group's research focuses on the rational drug design of a novel peptidomimetic of the D-Ala-D-Ala peptidoglycan moiety as a bacterial cell wall synthesis inhibitor. This past summer we worked on the synthesis of one diastereomer of this peptidomimetic. The synthetic approach to two diastereomeric series of these compounds involves an amide enolate alkylation using R-prolinol as a chiral auxiliary and two isomeric epoxides derived from D-alanine.

AB-INITIO STUDIES OF SUBSTITUTED *BIS*(CYCLOPENTADIENYL)BORANES AND BORONIUM IONS. ***William H. Ilsley,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The results of RHF/3–2lg* and RHF/6–3lg* calculations performed on substituted *bis*(cyclopentadienyl)boranes, of the type $(X_nC_5H_{5-n})_2BY$, and boronium ions of the type $[(X_nC_5H_{5-n})_2B]^+$, where, X = FMe, will be presented, The effects of both the substituents and the basis set used on the geometry and electronic structures of these species will be presented.

INITIAL STUDY OF ALTERNATIVE SYNTHESES FOR TELLURIUM ALKOXIDES. ***P. Brian Spangler* and J. M. Iriarte-Gross,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Tellurium alkoxides are used in many applications including as reagents to synthesized ceramics, using the sol-gel method. Although selenium and tellurium alkoxides have been synthesized, alternative methods have been investigated. Method development and preliminary results will be discussed.

CONFIRMATION THAT Ce(IV)/SiO_2 FUNCTIONS AS A SOLID-SUPPORTED REAGENT DURING HYDROQUINONE OXIDATION. ***Jennifer G. Martin-Tarpley* and Martin V. Stewart,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The traditional procedure for conducting an organic reaction of having both the starting compound and reagent in a homogeneous medium has been extended to heterogeneous conditions by stirring a solution of the starting material over a solid-supported reagent, which often gives a higher product yield under mild conditions. The oxidizing agent Ce(IV)SiO_2 is prepared by coating silica gel with ceric ammonium nitrate and is used to oxidize hydroquinones to their corresponding 1,4-benzoquinone. Analytical results from ^{1}H-NMR spectroscopy, including detection limits, will be presented to demonstrate that heterogeneous oxidation only occurs when Ce(IV) is supported on the surface of silica gel, and is not promoted by the individual components of this solid-supported reagent either separately or when physically mixed.

THEORETICAL STUDIES AND SELENIUM-77 CHEMICAL SHIFT DATA FOR THE SERIES $(CH_3)_{4-x}Si(SeCH_3)_x$. ***Zahra Rezaei*, Judith Iriarte-Gross, William H. Ilsley, and Brian Hill,*** *Middle Tennessee State University, Murfreesboro, Tennessee (ZR, JIG, WHI) and Bryan College, Dayton, Tennessee (BH).* Of particular interest is the nature of the silicon-selenium bond in the series, $(CH_3)_{4-x}Si(SeCH_3)_x$. Gas phase ab-initio (RHF) calculations have been conducted on these compounds. Selenium-77 NMR chemical shift data and the results of our theoretical studies will be presented and discussed.

SYNTHESIS, NMR, AND RHF/PM3 STUDIES OF THREE ARYL (PENTACHLOROCYCLOPENTADIENYL) MERCURY (II) COMPOUNDS. ***Mirfet Abdelhadi*, William H. Ilsley, and James C. Howard,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Three different aryl(pentachlorocyclopentadienyl) mercury (II) compounds of the type, $RHgC_5Cl_5$ (where R = 3,5-deimethylphenyl, 2,6-dimethylphenyl, and 2,3,5,6,tetramethlyphenyl) have been prepared and characterized by ^{1}H and ^{13}C NMR. The compounds were prepared by reacting the symmetrical bis (aryl)mercury(II) derivatives, R_2Hg, with bis(pentachlorocyclopentadienyl)mercury(II), $(C_5Cl_5)_2Hg$, in methylene chloride, CH_2Cl_2. The symmetrical derivatives were prepared from the corresponding Grignard reagent, RMgBr. In addition, three unsymmetrical compounds of the type, $RHgCH_2CH_2CH_2CH_3$, have been prepared by reacting the corresponding aryl bromides with mercuric bromide, HgBr2, in n-butyl lithium. These results along with proposed structures predicted from semi empirical RMF/PM3 calculations are presented. The fluxional behavior of 2,6-dimethylphenyl(pentachlorocyclopentadienyl)mercury (II) has been examined in solution by variable temperature NMR spectroscopy and by Nuclear Quadrupole resonance (NQR) spectroscopy in the solid state.

A MODEL FOR THE HUMAN ANDROGEN RECEPTOR LIGAND BINDING DOMAIN USING MOLECULAR DYNAMICS SIMULATIONS. ***Craig A. Marhefka, Bob M. Moore II, and Duane D. Miller,*** *The University of Tennessee, Memphis, Memphis, Tennessee.* Androgen receptor agonists and antagonists have clinical use in the treatment of various disease states; therefore, a 3-D model could aid in the design of new human androgen receptor (hAR) ligands. There is no 3-D structure for the hAR. However, the human progesterone receptor (hPR) has high homology (87%) with the hAR. The hPR crystal structure was used to build a theoretical model for the hAR ligand binding domain (LBD). Mutation of the hPR to the hAR followed by a series of minimizations was the first step in model building. Molecular dynamics simulations were performed giving ensembles of structures that were then time averaged giving the simulation structure. The results of the simulations show that the 17-OH group of testosterone forms H-bonds to THR-877 and ASN-705 while the 3-Keto group H-bonds to GLN-711 and ARG-752. These results are consistent with experimental observations and are being used in the development of new hAR ligands.

FATTY ACIDS AS CLASSIFICATION FACTORS IN FISH. ***Le-Ellen Dayhuff, Christopher J. O'Bara, and Martha J. M. Wells,*** *Tennessee Technological University, Cookeville, Tennessee.* Essentially all plants and animals are composed of lipids,

which influence survival, reproduction, growth, and energy reserves. Lipids provide insulation and protection to various parts of the body, particularly vital organs. Without lipids, cellular structure could not be maintained because they play an important role in separating, surrounding, and partitioning living cells from other cells and their environment. The lipid content of an organism and the fatty acid composition of these lipids depends on biological and physiological processes and environmental conditions. Therefore, the lipid content and distribution of individual fatty acids in fishes may vary among age, sex, species, location, or season. All of these factors may be influenced by diet, as the food supply of fishes differs among bodies of water over time according to environmental conditions. In this study, fish fillet samples were analyzed for fatty acid composition. Lipids were extracted from the white muscle tissue. Fatty acids were hydrolyzed from the lipids, esterified to fatty acid methyl esters (FAME), and analyzed by gas chromatography. The weight percent of linoleic acid (18:2n–6), linolenic acid (18:3n–3), arachidonic acid (20:4n–6), docosahexaenoic acid (22:6n–3), and ten other acids, were determined using stearic acid (18:0) as a reference standard. The data were statistically compared to establish differences and similarities among fish habitat, species, location, age, sex, and season. Results of this study are important to fisheries managers. The technique can be used as a forensic tool to differentiate native and cultured fish in order to discourage commercial fraud. The data increased our understanding of how fatty acids can be used to classify fish.

CESIUM-137 IN NORTHEAST TENNESSEE, AND ITS RELATION TO THE SURROUNDING ENVIRONMENT. ***Mohamed Y. Z. Aboul Eish, G. Kim Stearman, Dale D. Ensor, Munther M. Hindi, and Martha J. M. Wells,*** *Tennessee Technological University, Cookeville, Tennessee.* Gamma-ray measurement was performed to determine the Cs-137 activity in soil samples from an area in northeastern Tennessee. Cs-137 in the soil samples resulted from global fallout (1945–1986). The objective of this research was to determine if Cs-137 is useful as an environmental marker for various land uses within a watershed. Cs-137 activity in the soil could provide useful information about soil erosion in the area. Soil samples were dried, ground, and sieved before analysis. A high purity germanium detector was found to produce a better response than a thallium activated sodium iodide crystal. The activity of Cs-137 was noted to distinguish between disturbed and undisturbed soils. A pattern of within-watershed similarity was observed among unclassified peaks in the spectrum assumed to result from long-lived, naturally occurring uranium and thorium daughters.

MONITORING ENGINE EMISSIONS WITH ULTRAVIOLET/VISIBLE SPECTROSCOPY. ***Serhiy Hnatyshyn, Jennifer Castro, Paul D. Marshall, Norma L. Ayala, Tye Ed Barber, John M. E. Storey, and Bill Partridge,*** *Tennessee Technological University, Cookeville, Tennessee (SH, JC, PDM, NLA, TEB), and Oak Ridge National Laboratory, Oak Ridge, Tennessee (JMES, BP).* To develop better engines and to determine their impact on the environment, engine manufacturers and regulators are currently interested in monitoring the concentration of more than 150 compounds in the exhaust from internal combustion engines. Currently, the concentrations of these compounds are measured using infrared absorption spectroscopy, gas chromatography, or mass spectroscopy. Due to the complexity of engine exhaust, these techniques are not suitable for the determination of all the compounds of interest. The current techniques are either too expensive or lack sufficient sensitivity. In this presentation, the use of ultraviolet/visible absorption spectroscopy for the determination of several species that are difficult to quantify using current methods will be discussed.

DETERMINATION OF THE COMPOSITION OF ENGINE DEPOSITS USING INFRARED SPECTROSCOPY. ***Serhiy Hnatyshyn, Roopali Panchal, Paul D. Marshall, Norma L. Ayala, Tye Ed Barber, G. Louis Powell, John M. E. Storey, and Bill Partridge,*** *Tennessee Technological University, Cookeville, Tennessee (SH, RP, PDM, NLA, TEB), and Oak Ridge National Laboratory, Oak Ridge, Tennessee (GLP, JMES, BP).* Modern internal combustion engines are designed to operate at extremely close tolerances. Because of these close tolerances, any formation of engine deposits can potentially degrade engine performance. This can cause increased engine wear and higher emissions. Although engine deposits have been studied for many years, their chemistry is still not completely understood. Their formation and growth are determined by a variety of factors including engine load, air/fuel ratio, fuel composition, and oil composition. To gain a better understanding of engine deposits, better analytical techniques for characterizing engine deposits are needed. In this presentation, the characterization of engine deposits using infrared spectroscopy will be discussed.

ADDITION OF NUCLEOPHILES TO THE CARBONYL CARBON OF AN ALPHA-HALO KETONE TO FORM EPOXYETHERS. ***William E. Solomons,*** *The University of Tennessee, Martin, Martin, Tennessee.* Nucleophiles have been reacted with an α-halogenated slightly α-sterically hindered ketone, desyl chloride (α-chloro-α-phenylacetophenone) to form an epoxy ether (1-alkoxy-1,2-diphenyl oxirane). Attempts with isopropoxide, piperidine and thiophenoxide failed, but attempts with *t*-amyloxide appear to have given the desired product. Fragmentation pathways of this product in the MS will also be discussed. Additional reactions with a variety of substituents will be pursued.

PH STUDIES OF TELLURIC ACID. ***Freneka F. Minter and Judith Iriarte-Gross,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Telluric acid, $Te(OH)_6$, is a potential chemical shift reference for tellurium-125 NMR spectroscopy. It is well known that tellurium-125 chemical shifts are sensitive to concentration, solvent, temperature, and pH. The results of pH studies of $Te(OH)_6$ will be presented and discussed.

PROJECT SEED AT MIDDLE TENNESSEE STATE UNIVERSITY 1999. ***Stefanie Evagues, Judith Iriate-Gross, and William Ilsley,*** *F. C. Boyd Sr. Christian School, McMinville, Tennessee (SE), and Middle Tennessee State University, Murfreesboro, Tennessee (JIG, WI).* Project SEED is a program of the American Chemical Society that provides opportunities to high school students to conduct research in university, government, and private industry laboratories. SEED students must have an interest in science, one year of high school chemistry, and must meet certain financial guidelines. The SEED student is introduced to chemical and safety literature, synthetic techniques, and modem analytical instrumentation. The student also becomes a member of the research group team and participates in regular group meetings during the summer months. The Department of Chemistry at Middle Tennessee State University has been hosting SEED stu-

dents since 1997. This poster presents the work of Stefanie Evagues, a SEED I scholar for 1999.

ENGINEERING AND ENGINEERING TECHNOLOGY SECTIONS

PATRICIA DYCUS, CHAIR, AND DON VISCO, CHAIR

MODELING CHANGES OF THE CEREBRAL VASCULATURE INDUCED BY VARIATIONS OF PCO_2. ***Richard Pasley, Chunzhi Wang, Charles W. Leffler, and Michael L. Daley,*** *The University of Memphis, Memphis, Tennessee (RP, CW, MLD), and The University of Tennessee, Memphis, Memphis, Tennessee (CWL).* Clinical recordings of intracranial pressure (ICP) and arterial blood pressure (ABP) of patients with brain injury vary. For one pathophysiologic state, the pressure recordings are dissimilar, while in another they are similar. The purpose of this study was to develop a model that describes the changes observed in coefficients of correlation readings. The model assumes compression of the cerebral capillary bed by transmission of changes of intrathoracic pressure associated with ventilation. During normal vascular tone, the ICP and ABP recordings are dissimilar and the compression effect is minimal. The compression effect progressively reduces as tone is lost and the recordings become markedly similar. The model is designed to generate a theoretical ICP wave for different amounts of PCO_2 using a given APF waveform. Coefficients of correlation are then calculated to demonstrate the model performs as predicted.

SUPERINSULATIONS: USE IN MANUFACTURED HOMES. ***David W. Yarbrough,*** *Tennessee Technological University, Cookeville, Tennessee.* Superinsulations produced by encapsulating evacuated fine powders have thermal resistances at 300K that are 5 to 10 times greater than those of conventional air-based thermal insulations. Evacuated powder-filled systems at absolute pressures around one torr have been used successfully in household appliances and commercial low-temperature applications. Evacuated superinsulations have application in manufactured homes as roof-cavity insulation. Limited space for insulation in many commonly produced manufactured home units provides the opportunity for these high-thermal resistance products. The general theory of evacuated superinsulations and the results of a recently completed field study will be presented.

INTRACRANIAL PRESSURE: SPECTRAL CHARACTERISTICS OF B-WAVES AND OTHER LOW-FREQUENCY ACTIVITY. ***Michael L. Daley, Dien Nguyen, Matthew J. L. Connolly, Shelley Timmons, John Angel, and Charles W. Leffler,*** *The University of Memphis, Memphis, Tennessee (MLD, DN, MJLC), and The University of Tennessee, Memphis, Memphis, Tennessee (ST, JA, CWL).* Low frequency oscillations of intracranial pressure (ICP) in the range of 0.5 to 2.0 cycles/min have been termed B-waves. Such oscillations may or may not be synchronized with ventilation and/or arterial blood pressure. The objectives of this study were to: 1) describe the low frequency spectral characteristics of ICP and ABF recordings with a mathematical model based on pleural pressure modulation of the vasculature, and 2) classify B-waves and other slow wave activity according to their spectral properties. The linear modulation model predicted the frequency location of spectra associated ventilation of six clinical pressure recordings with B-waves to within a 1% error. Variation of heart-rate was not associated with the occurrence of B-waves. It is concluded that the low frequency spectra of ICP recordings containing waves synchronized with ventilation can be accurately described by a mathematical model of modulation by pleural pressure.

THE K-FACTOR METHOD: A NEW IMAGE PROCESSING TOOL. ***Jaime R. Taylor,*** *Austin Peay State University, Clarksville, Tennessee.* A new computational paradigm is introduced. Other image representations such as Fourier transforms and wavelength decompositions depend on linear superposition of basis functions. The k-factor image factorization reduces an image into a finite or infinite set of contrast-ordered images whose joint product reproduces the original image. It is experimentally found that shadows and noise often fall into factors disjoint from the "pure" image. The analytical foundations of the k-factor method are given followed by full factorizations and reconstructions. An application to shadow removal is presented and future research directions are described that include image compression, medical and military image analysis, and commercial applications.

NON-INVASIVE METHOD OF ASSESSING RELATIVE CHANGES OF CEREBRAL BLOOD VOLUME. ***Ricky Dorsey*, Nicole Bond*, Monique Reeves*, Richard Pasley*, and Michael L. Daley,*** *The University of Memphis, Memphis, Tennessee.* Knowledge of the ability of the cerebral vasculature of a patient with severe head-injury to dilate and constrict is of value during emergency and intensive care management. Near infrared spectroscopy (NIRS) provides a non-invasive means of monitoring change of cerebral blood volume. The purpose of this pilot study was to determine whether or not a non-invasive method based on NIRS could detect cerebral vascular changes in response to increases and decreases in cerebral perfusion pressure. Three subjects were used to develop the instrumentation. Each subject was instructed to lie quietly on a horizontal mattress supported by a wooden base. A hydraulic jack attached to the middle of either the head or foot of the base was used to tilt the subject either 15 degrees head-up or 15 degrees head-down. Preliminary recordings of NIRS during the tilt-up response indicate that compensatory cerebral vascular dilation following the stop change in body angle requires 20 to 50 sec.

A METHODOLOGY FOR THE EVALUATION OF THE TENSILE CREEP BEHAVIOR OF ULTRA-HIGH-MOLECULAR-WEIGHT POLYETHYLENE. ***Eric Walker, Krishy Gopalapillai, and Gladius Lewis,*** *The University of Memphis, Memphis, Tennessee.* Ultra-high molecular-weight polyethylene (UHMWPE) is widely used for fabricating bearing components for total joint replacements, such as the acetabular cup liner in total hip-joint replacements and the tibial insert for total knee-joint replacements. Maintaining the original properties of UHMWPE is very important for the in vivo performance of these components. Therefore, any potential adverse effects on UHMWPE (that may be caused by fabrication, or sterilization methods) should be avoided or minimized. In the present work, creep elongation-versus-time results for four sets of UHMWWE specimens (unsterilized, gamma-irradiated, ethylene gas-sterilized, and gas plasma-sterilized) were obtained at three stress levels. These data were then converted to creep strain rate-versus-stress formats; hence, estimates of the constants in the Norton equation were determined. The advantages and drawbacks of this methodology,

the effect of sterilization method on the Norton constants, and the potential clinical significance of these results are fully discussed.

DIGITAL IMAGE ANALYSIS: OSCILLATIONS OF THE CEREBRAL ARTERIOLES DURING VENTILATION. ***Sulhyung Han, Clarles W. Leffler, and Michael L. Daley.*** *The University of Memphis, Memphis, Tennessee (SH, MLD), and The University of Tennessee, Memphis, Memphis, Tennessee (CWL).* During positive pressure ventilation, intracranial pressure (ICP) progressively increases at the onset of the positive pressure inhalation phase of ventilation and decreases during the passive pressure expiration phase. It has been posited that cyclic changes of ICP synchronized with mechanical ventilation may be due to cyclic compression of the cerebral capillary bed by mechanical ventilation. With a cranial window preparation, digital images (640 × 480 pixel/frame, resolution of 1 pixel per 1.2 μm) of S-VHS recordings of the cerebral pial vasculature were obtained during normal tone and maximal dilation induced by hypercapnia. Because of brain movement during ventilation, a method of visual labeling of pixels to track the same edge point was devised. Frame by frame computation of arteriolar diameter was accomplished. Oscillations of the pial arteriolar diameter were synchronized with mechanical ventilation. The preliminary results support the premise that pial arterioles dilate during positive pressure inhalation.

ACOUSTIC EMISSION ANALYSIS DURING FATIGUE CRACK PROPAGATION IN PALACOS R BONE CEMENT. ***Eng-Teik Ng and Gang Qi.*** *The University of Memphis, Memphis, Tennessee.* The fatigue crack propagation behavior of the Palacos R bone cement under tension-tension cyclic loading is presented. Compact tensile fatigue specimen was used according to ASTM Standard E399–90. The acoustic emission (AE) technique as a nondestructive evaluation technique was applied to characterize the relationship between cement fatigue failure and AE parameters. In this research, standard fatigue tests are presented. Crack propagation and AE signal were recorded during the experiment. The crack formulation and initiation were related to AE parameters such as ringdown counts, events, and amplitudes. The empirical relationship between Paris Law parameters and AE Parameters mentioned above derive from the experimental data. The results show good agreement between the empirical relationship and the test data. Therefore, the AE technique is an effective tool for fatigue investigation of bone cement.

USE OF AN ACOUSTIC EMISSION TECHNIQUE TO MONITOR AND ANALYZE FATIGUE FAILURE OF FEMUR PROSTHESES. ***Zaifeng Fan and Gang Qi,*** *The University of Memphis, Memphis, Tennessee.* Acoustic Emission (AE) technique is used to monitor and analyze fatigue failure of femur prostheses. During the tests, detailed failure information is recorded in the form of AE parameters, such as amplitude, energy, and counts in real time. This method can be used to observe the initiation and propagation of failure inside the material in real time, and therefore to quantitatively control the quality. A total of 5.5 million cycles were conducted with three time intervals. This research suggests that AE technology can detect fatigue failures in cemented prostheses. In the region where AE signals suggest failure location, supportive physical deterioration evidence can be shown by microscopic observation. AE can be used to reveal the structural deterioration history of the specimen. The present study also proves that failure initiation and propagation can be accurately detected. Furthermore, the significant variation in AE parameters observed in each of the three time intervals warrants further study.

FINITE ELEMENT EVALUATION OF MECHANICAL BEHAVIOR OF SPINAL INSTRUMENTATION RELATED TO ROD CROSS-SECTIONAL SHAPE: SQUARE VS. CIRCULAR. ***Yingwu Cui and Gary Qi,*** *The University of Memphis, Memphis, Tennessee.* Few studies concerning the mechanical behavior of spinal instrumentation using finite element method have been reported. In this study, three-dimensional finite element models of six variants of a spinal instrumentation system (TSRH) with eight-hook pattern were developed. In three cases, the rod cross section was circular (CCS cases, currently standard design), while it was square in another three cases (SCS cases). The results show that CCS and SCS rod designs with the same flexural rigidity have about the same axial stiffness, but the SCS rod design has a noticeably lower value of the maximum von Mises stress. Furthermore, the SCS rod design has some perceived advantages over the CCS one. For example, the potential for sliding of cross-links and hooks along the rod is lower when the former design is used. Thus, it is recommended that serious consideration be given to fabricating spinal implant systems with square cross-sectional rods.

MORPHOLOGY AND MECHANICAL PROPERTIES OF OPEN POROUS ULTRA HIGH MOLECULAR POLYETHYLENE (UHMWPE) FOR BIOMEDICAL APPLICATIONS. ***T. A. Venkatesh and F. Shutov,*** *Tennessee Technological University, Cookeville, Tennessee.* Ultra High Molecular Weight Polyethylene (UHMWPE) has been used as the bearing material in the majority of joint endoprostheses for more than 25 years. This application is based on the fact that some crucial properties of UHMWPE, such as impact strength, low friction coefficient, and a relatively high resistance to wear, are superior to other polymers. However, solid UHMWPE parts can not completely replace the natural part, because the latter has a porous structure and self-lubricating properties. In order to overcome the disadvantage of solid UHMWPE parts, a novel process was developed for the manufacture of porous parts using compression molding technique. After post treatment, the UHMWPE slab has open pores of 50 μm or less, and there is a uniform distribution of the pores throughout the samples. The process allows control of pore size and distribution, and the thickness of the part. Some mechanical properties of the developed material have been studied. The porous samples, which are permeable to liquids, can be used as a substrate matrix in bone regeneration and in hip and knee joint replacements.

PREDICTION OF SHRINKAGE AND EVAPORATION OF CONCRETE DECK SLAB. ***Ling Ung Wong and Sharon X. Huo,*** *Tennessee Technological University, Cookeville, Tennessee.* The prediction of shrinkage and evaporation of concrete deck slab is presented. Shrinkage is the decreasing of the volume of materials. The shrinkage of concrete is mainly affected by the type of cement, aggregate, water-cement ratio, chemical admixtures, pozzolans, duration of moist curing, size of members, relative humidity, and curing time. There are three kinds of concrete shrinkage: drying shrinkage, autogeneous shrinkage, and carbonation shrinkage. Because evaporation controls the loss of moisture from concrete during the curing period, the prediction of evaporation rate also is presented. The rate of evaporation of

concrete depends on relative humidity, temperature, pressure, wind velocity, surface area, and the concrete temperature. Two models are used to predict concrete shrinkage. TDOT High Performance Concrete mix is used for the predictions. The first model was developed by Hansen at the University of Michigan, and the second model is the one recommended by ACI. The Hansen model utilizes the theory of elasticity of the component of the concrete for predicting ultimate drying shrinkage. The prediction also depends on the shrinkage of cement paste. The experiment was run to determine the shrinkage of cement paste. The ACI method considers ambient relative humidity, and concrete properties like member size, slump height, aggregate percentage, cement content, and air content in predicting the concrete shrinkage. Uno's equation is used to predict the rate of evaporation. Concrete temperature, air temperature, relative humidity, and wind velocity are considered in the equation.

MATERIAL COMPATIBILITY WITH HIGH TEST HYDROGEN PEROXIDE ROCKET PROPELLANT. ***Rudy Gostowski and Tom Owens,*** *Austin Peay State University, Cookeville, Tennessee, and Marshall Space Flight Center, Huntsville, Alabama.* High test (90–98%) hydrogen peroxide (HTP) has been successfully used as a rocket propellant for many vehicles. The goal of this work was to develop a new scheme for evaluation of the compatibility of various materials, specifically metals, with HTP. To accomplish this goal various testing methods were compared. These included observation of reactivity (bubbling, evolution of steam, or temperature rise), concentration and mass loss analysis following accelerated aging, and detection of an exothermic process by differential scanning calorimetry. As listed each technique provided a greater degree of sensitivity to detect less reactive materials. In this preliminary study the metals evaluated yielded similar results to a previous rating scheme. Accelerated aging coupled with mass loss-concentration analysis was more sensitive than visual observation of reactions at ambient temperature. However, calorimetry appears to be the most sensitive method to evaluate metals and further studies will be focused in that area.

PREDICTIVE COMPUTER MODELING OF FEED AND GROWTH RATES FOR PACIFIC WHITE SHRIMP IN HARD FRESH WATER. ***Anthony F. Pegel and J. Richard Booth,*** *Tennessee Technological University, Cookeville, Tennessee.* Feed costs can represent as much as 60% of total production costs for aquaculture systems. To maximize growth and feed efficiency, the development of a predictive computer model for feed and growth rates of Pacific White Shrimp, *Pennaeus vannamei,* in a hard freshwater aquaculture system is being developed. The model predictions are calculated from the overall material balance. Growth and feed rates are based on the limiting amino acid and/or lipid present in the specific feed. Amino acid and lipid compositions are determined for various feeds and for shrimp at various stages of development. Feed composition and shrimp metabolic requirement are compared to predict the most efficient feed type and corresponding feeding. This allows for maximum shrimp growth while minimizing feed cost.

WEB-BASED ELECTRONIC TECHNOLOGY LABORATORY. ***Adel Salama and Ashraf Saad,*** *Austin Peay State University, Clarksville, Tennessee, and University of Cincinnati, Cincinnati, Ohio.* Distance Education over the Web is increasing at an exponential rate with many learners bound to receive academic degrees entirely over the Internet. A number of projects at various institutions are therefore currently underway to develop Web-based courseware for a large proportion of the Electronic Engineering Technology curriculum. These projects include Advanced Technological Education projects recently funded by the National Science Foundation. These projects are striving to realize a vision for modern Technology Instruction that can be deployed over the Web. Current projects include a complete interactive Web-Based Electronics Technology Laboratory System. These systems provide a "virtual" laboratory environment and are therefore moving traditional lab instruction to using Internet technology for local or remote Web-based instruction and communication. This approach holds great promise since it should lead to a reduction in the cost of purchasing and maintaining lab equipment as well as enhancing student interest. An essential concept behind a Web-Based Lab is to provide the Virtual Equipment necessary to conduct an electronics lab on-line, such as Dual Channel Oscilloscope, Digital Voltmeter, Triple Programmable Power Supply, Spectrum Analyzer, Signal Generator, Strip Chart Recorder, and Frequency Counter.

LATTICE BOLTZMANN METHOD FOR SIMULATION OF FLOW THROUGH MICROCHANNELS. ***Kaushal B. Mehta and Joseph J. Biernacki,*** *Tennessee Technological University, Cookeville, Tennessee.* Gas and liquid microflows are encountered in many applications of Micro-Electro-Mechanical Systems (MEMS). Understanding the physics of such flows is an important element in designing, fabricating, and operating MEMS, for which microchannels are basic elements. To date, there is no satisfactory theoretical explanation for the observed behavior of the flows of fluid, even in simple planar microchannels. Due to their small sizes, the conventional continuum approach methods are not appropriate for studying the flow characteristics of MEMS. Computational modeling and simulation can provide an effective way of predicting the heat and momentum transfer in microsales, which in turn will help to evaluate the performance of a new microdevice before hardware fabrication. The Lattice Boltzmann Method (LBM) has developed as a promising method for simulation of flow in microporous arbitrary geometries. LBM is effective because it is a method for direct modeling of the physics in fluids and it is very successful in simulating fluid flows involving interfacial dynamics and complex boundary conditions. The basic idea of this model is to construct simplified kinetic models that incorporate the essential physics of microscopic or mesoscopic processes so that the macroscopic averaged properties obey the desired macroscopic equations. We propose extending this technique to model flow in microsystems.

STUDY OF THE REACTION BETWEEN FLY ASH AND CALCIUM HYDROXIDE. ***Jenny Lau Eik Lang and Joseph Biernacki,*** *Tennessee Technological University, Cookeville, Tennessee.* The demand for concrete is increasing every year due to the rapid development of constructed infrastructure around the world. Consequently, large-scale industrial production of cement results in high amounts of carbon dioxide (CO_2) being released into the atmosphere. In order to reduce the amount of CO_2 produced while supplying enough cement to the construction industry, materials such as fly ash can be used to partially substitute for cement in concrete. Fly ash, a common waste material produced by the combustion of coal and one of the world's most commonly used pozzolans, is characterized by an ability to react with hydrated lime from cement to form a hardened cementitious

material. Although fly ash has been in concrete for many years, the fundamental chemical and physical changes that occur in these systems are still not clearly understood. To predict the performance of fly ash and other blended cements in concrete by using materials science-based mathematical simulations, detailed knowledge of the chemical and physical changes that happen during hydration are needed. However, this can be very complicated due to the complex system of chemical reactions that take place in the process of cement hydration. To simplify the process, instead of investigating the reaction between Portland cement and fly ash, a model system containing calcium hydroxide (CH), a by-product of cement hydration, and fly ash was studied. When mixed with water and CH, fly ash reacts by forming cementitious products similar to those produced by hydration in Portland cement phases. Recent studies suggest that the rate of the reaction may be controlled by the surface of CH as shown by an increasing consumption rate of CH content of the system. Several hypotheses, such as the effect from particle proximity (transport distance between particles) and pH consistency, have been proposed to account for these observations. The objective of this research was to test these hypotheses, to better understand the reaction mechanism between fly ash and CH hydroxide, and to calibrate various parameters in existing hydration models for the accurate prediction of fly ash-CH interaction.

COMPETENCY-BASED INFORMATION TECHNOLOGY COURSE AND CURRICULUM DEVELOPMENT. ***Ashraf Saad and Adel Salama,*** *University of Cincinnati, Cincinnati, Ohio, and Austin Peay State University, Clarksville, Tennessee.* The Ohio Information Technology (IT) Competency Profile was developed under the guidance of the Joint Council of the Ohio Board of Regents and the State Board of Education. It provides the framework for a broad-based educational response to Ohio's need for a skilled information technology workforce, along a Tech Prep model of curriculum development. The profile includes a comprehensive set of information technology competencies that are structured along four Information Technology tracks, namely: Information Services and Support, Network Systems, Programming and Software Development, and Interactive Media. The IT Competency Profile can therefore serve as the basis for a "2+2+2" seamless transition for students, leading to a career in the IT industry. Such a pathway will start during the junior year in high school, through an associate degree at the community college level, or at the University of Cincinnati (UC), and on to a Bachelor of Science degree in Information Engineering Technology at UC's OMI-College of Applied Science. Such a framework also should lead to updating course and curriculum material on a yearly basis "vertically" across all partner institutions at all three educational levels. This should in turn serve as a model for other institutions around the State of Ohio, and nationally, thereby helping to alleviate the current and future shortage of IT workers. More information about the Ohio Information Technology Competency Profile can be found at *www.itworks-ohio.org.*

THERMODYNAMIC MODELING OF HYDROGEN FLUORIDE. ***Donald P. Visco Jr. and David A. Kofke,*** *Tennessee Technological University, Cookeville, Tennessee, and State University of New York, Buffalo, Amherst, New York.* Hydrogen fluoride (HF) is notoriously difficult to model using conventional methods owing to its strong association in both the liquid and vapor phases. As such, other means have been developed in an attempt to describe the thermodynamic properties of HF. In this work, we look at two such models and determine the VLE, heat of vaporization, and heat capacity as calculated from these equations relative to experimental data. Additionally, we modify one of the models to improve its agreement with experimental heat capacity data.

STABILIZATION OF ASCORBIC ACID LOTION. ***Jackie McAreavey and Patricia J. M. Dycus,*** *Tennessee Technological University, Cookeville, Tennessee.* Ascorbic acid, commonly known as vitamin C, has become an increasing topic of research. While vitamin C is widely accepted as a defense against the common cold, vitamin C also has been suggested to play a role in cancer prevention. Vitamin C contributes an important function in the formation and maintenance of collagen, which is found in skin, ligaments, cartilage, vertebral discs, joint linings, capillary walls, and bones and teeth. Thus, it is obvious that vitamin C, is at the root of the preservation of the body's structure and shape. It also is believed that vitamin C can reverse the damages caused by the sun and oxidants. The unfortunate truth is that humans are one of very few species that do not produce vitamin C. Therefore we have to obtain it through other means. The body uses the vitamin C that is acquired through diet very fast, approximately within four hours. Therefore, because most people do not even achieve the recommended daily amount through their diet, it would be beneficial to develop a stable form of this fundamental vitamin that could be readily applied directly to the skin.

STUDY OF THE MECHANICAL PROPERTIES OF FOAM-IN-FOAM POLYURETHANE MATERIALS. ***Y. Yuan and F. Shutov,*** *Tennessee Technological University, Cookeville, Tennessee.* Open-pore flexible polyurethane (PUR) foams with various pore sizes (1–8 mm) were used as filler to reinforce low-density closed-cell PUR flexible foam. The final composite has a foam-in-foam structure. Compared to the unfilled PUR flexible foam, the composite exhibited improved mechanical properties: the normalized compressive modulus increased up to 11 times. A model developed for cellular material was used to predict the compressive modulus of the composite and the results were compared to the experimental data.

ETHICS IN SCIENCE AND TECHNOLOGY SECTION

RUBYE PRIGMORE-TORREY, CHAIR

COMPUTER-SCIENCE STUDENT RESPONSES TO LEGISLATION, LITIGATION AND LEGALISMS. ***M. Gene Bailey and Ruth Knight Bailey,*** *East Tennessee State University, Johnson City, Tennessee.* In addition to studying traditional curriculum, our computer-ethics students write journals wherein they share personal insights gained as they analyze the new problems and subtleties caused by rapid growth in the field of computer science. The journal entries presented herein offer refreshing insights to lawmakers and educators as they face technology's effect upon established principles relating to commerce, privacy, crime, safety, and legal jurisdiction, as well as copyrights, patents, and trademarks.

ASSISTED REPRODUCTION: ETHICAL ISSUES ASSOCIATED WITH HUMAN CLONING. ***Rebecca L. Seipelt,*** *Middle*

Tennessee State University, Murfreesboro, Tennessee. The cloning of Dolly, the sheep, has advanced the possibility of human cloning beyond the fantasy realm. Several scientists have announced intent to clone humans. Motivation includes allowing infertile couples to have children, obtaining spare body parts, recreating "loved ones", gathering scientific knowledge, and indulging general curiosity. Regardless of intent, the technology must be evaluated in light of possible abuses such as creating populations of "worker" clones or "designer" children. Another consequence might be loss of genetic diversity. This debate leads to many difficult questions. What is an individual's value? Would clones have "human" rights? Who controls which people are cloned? Can and should human cloning technology be controlled? How much human genetic diversity is needed? These questions may never be answered to our satisfaction, but we must face the fact that human cloning is becoming reality. In the absence of forethought and action, any technology likely will be abused.

ETHICS IN THE ACADEMY: THE INSTITUTION OF RESEARCH. ***Rubye Prigmore-Torrey,*** *Tennessee Technological University, Cookeville, Tennessee.* The Tennessee Academy of Science (TAS) may be defined as a society of learned persons organized to advance knowledge in all disciplines. These learned persons are often referred to as scholars. The question is: Are scholars to be exempt from the practice of ethics? The answer to this question is a resounding NO! The institution of research, which is an intricate part of the mission of the TAS, provides a perfect arena for the practice of ethical principles. The scholars of the TAS who push back the frontiers of knowledge through research should be the leaders in the practice of ethical principles. Case studies will be used to illustrate the role of research scholars in giving ethics a fundamental role in the TAS.

SODIS: A SOFTWARE ENGINEERING ETHICS TOOL. ***Mary Skiles Sullivan,*** *East Tennessee State University, Johnson City, Tennessee.* A SoDIS analysis was performed as a post-audit on a data warehousing project for a large organization. This organization had performed a detailed risk analysis during project development. In the post-audit, the SoDIS analysis found three major software engineering ethical issues violated which had gone undiscovered during the initial risk analysis. Although SoDIS worked well in a post-audit situation, SoDIS should be used as a pre-audit CASE tool. The primary function of SoDIS is as a decision-support tool during the project development stage. In summary, SoDIS helps record the details and resolutions of significant ethical issues identified during the development phase of a software project: issues related to individual project tasks. It helps track the decisions made to resolve ethical concerns and records those decisions as future tasks to perform before project completion. An overview feature allows the developer to carefully track tasks that have been flagged as potential harm to a particular stakeholder. A project plan is not complete until all flagged tasks have been addressed. The features of SoDIS allow a software engineer to ensure proper identification of professional/ethical concerns and ensure potential risks to stakeholders are resolved. The SoDIS process when incorporated into software projects as a pre-audit CASE tool will lead to ethically sound software.

ETHICS AND RADIATION RESEARCH. ***Cliff Honicker,*** *American Environmental Health Studies Project, Inc., Knoxville, Tennessee.* A brief overview of the work of the American Environmental Health Studies Project (AEHSP) with respect to human radiation experiments will be presented. The project began in 1984, with the initiation of a congressional investigation on government sponsored human radiation experiments through the Energy Conservation and Power Subcommittee of the House of Representatives. The 1986 Congressional Report "America's Nuclear Guinea Pigs" was the result of that research. A second example will be the Vanderbilt "Nutritional Study." This was a study conducted shortly after WWII that involved giving radioactive Iodine-131 to pregnant women without their knowledge or consent. AEHSP joined with two law firms and brought a class action lawsuit against Vanderbilt University and several other parties in the mid-1990's. That suit was recently settled for over $10 million. A third example relates to the issues of nuclear workers at Oak Ridge, Tennessee who have been injured by chemicals, heavy metals, and radionuclides. In this case, a national bill was created in Congress to compensate not only the injured workers in Oak Ridge, but similarly affected workers in other Department of Energy facilities across the country.

GEOLOGY AND GEOGRAPHY SECTION

DANIEL LARSEN, CHAIR

OCCURRENCE AND IMPACTS: THE CLARKSVILLE, TENNESSEE, TORNADO OF JANUARY 22, 1999. ***Robert A. Sirk,*** *Austin Peay State University, Clarksville, Tennessee.* The Middle Tennessee region is not a traditional site of extreme cyclonic activity. Recent history of the region has contradicted this fact, having seen the formation of numerous significant tornadoes. In the pre-dawn hours of January 22, 1999, Clarksville-Montgomery County and Austin Peay State University suffered such an incident. An F3 category tornado with estimated wind speeds of 200 miles/h cut a five-mile path through the city and the university. Both continue efforts to recover from that event. The potential of a tornado to wreak destruction is locked into elements of (1) its wind speed, (2) the strength of its pressure gradient, and (3) its ancillary airborne debris. These will be introduced, and from the perspective of these tornadic forces, the presentation examines destruction wrought by the Clarksville tornado event.

PORE-WATER PRESSURE AND WATER TABLE VARIATION DURING EARTHQUAKE SIMULATIONS. ***Natasha Ramsey*, Roy Van Arsdale, Robert A. Scarbrough, and Kevin Gough,*** *The University of Memphis, Memphis, Tennessee.* Shake table experiments were conducted on a cylinder of sand and water to monitor changes in water table height, pore-water pressure, and sand height during a simulated earthquake. Cylinder motion was kept constant as initial water table and sand column heights varied. Test results reveal: 1) maximum water table height and pore-water pressure occur when the sand column is approximately twice the initial water table height, 2) pore-water pressure remains high long after the shaking ceases, apparently due to the elevated water table, 3) with an impermeable layer the pore-water pressure continues to rise as the sand height increases, 4) with an impermeable layer pore-water pressure remains high long after the shaking ceases, apparently due to the lithostatic pressure of the sand column above the impermeable layer, 5) sand com-

paction occurs beneath the water table, and 6) the amount of sand compaction is controlled by initial water table height.

NO EROSION BY TORRENTIAL RAINS ALONG LEAF MAT-PROTECTED OLD NATCHEZ TRACE, LEWIS COUNTY, TENNESSEE. ***Richard G. Stearns,*** *Vanderbilt University, Nashville, Tennessee.* There are 750 m of abandoned old trace near Meriwether Lewis Monument. A 9–15 cm rain from March 2 to 2 AM March 3, 1997, only washed off one m of topmost leaves, exposing leaf mold. Soil remained covered. The 19–31 cm rain of July 13, 1998 did not erode the old trace, but leaves plus leaf mold were removed along 15 m (2%). Soil was not eroded. Leaf fall had since recovered all but 5 m. On paths where walkers tread leaves flat, both rains washed away leaves. Each leaf fall is 3–5 leaves deep. Leaf mats remain about 7 cm thick as old leaves decay to mold and newest leaves preserve the fluffy top surface. Mold develops in about three years; so abandoned trace segments were soon protected. However, rain like July 1998, can overtop the mat. Then velocity can increase to wash the mat away.

RECORDS OF FOSSIL VERTEBRATES FROM TENNESSEE: CRETACEOUS TO EARLY HOLOCENE. ***James X. Corgan, Emanuel Breitburg, John B. Broster, William C. Dickinson, Timothy J. Gaudin, Earl M. Manning, and Paul W. Parmalee,*** *Austin Peay State University, Clarksville Tennessee (JXC), Tennessee Division of Archaeology, Nashville, Tennessee (EB, JBB), Hiwassee College, Madisonville, Tennessee (WCD), The University of Tennessee, Chattanooga, Chattanooga, Tennessee (TJG), Tulane University, New Orleans, Louisiana (EMM), and The University of Tennessee, Knoxville, Knoxville, Tennessee (PWP).* A summary of Tennessee's prehistoric vertebrates, published in 1997, documented 245 species from 161 sites, ranging from Devonian to Pleistocene. There is no known post 1997 research on pre-Cretaceous faunas. Published studies, research now in progress, doctoral studies, and curated but inactive museum collections expand the number of known localities to 170, at a minimum. Pleistocene or older species exceed 300 with 18 more from the Early Holocene. Serious studies of Tennessee fossil vertebrates began with nineteenth century State Geologists. From 1900 through 1960, no author wrote more than four papers. Since 1961 more has been done due, in part, to co-operation among researchers, as evidenced by the authorship of this text. New research adds many fish and reptile species to Mesozoic and Eocene faunas. Pleistocene and early Holocene studies yield new Tennessee records for many species plus a new man-mastodon association and undescribed species of fossil fish.

DISTRIBUTION AND ORIGIN OF LATE CENOZOIC ALLUVIAL DEPOSITS IN SHELBY COUNTY, TENNESSEE. ***Daniel Larsen and Dessalines McCleod McClure,*** *The University of Memphis, Memphis, Tennessee.* Stratigraphic data for late Cenozoic alluvial deposits in Shelby County from field exposures, drillers logs, and geophysical logs were compiled to investigate their distribution and origin. Sediment characteristics and surface, structure-contour, and isopach maps demonstrate that the alluvial deposits include at least 2 distinct units. Topographically higher, highly oxidized, red sand and gravel deposits cap the hills and have basal elevations that do not follow the gradients of present-day western Tennessee streams. These deposits are tentatively correlated to the Plio-Pleistocene Upland Complex. Topographically lower, tan to black, sand and gravel deposits have basal elevations that follow the gradients of present-day streams and are tentatively correlated to Pleistocene terrace levels in the Mississippi embayment. The sand and gravel deposits at the lowest elevations in the western part of the county partially fill paleovalleys that graded to a base level at least 55 feet below that of the modern-day Mississippi River.

FAULT CONTROL OF THE CHICKASAW BLUFF/BIG CREEK LINEAMENT. ***Randel Tom Cox, Roy Van Arsdale, and James Harris,*** *The University of Memphis, Memphis, Tennessee (RTC, RVA), and Millsaps College, Jackson, Mississippi (JH).* The Chickasaw Bluff/Big Creek lineament (extending ~N45E from Arkansas into Tennessee) has been long suspected to be a fault of the seismogenic Reelfoot rift. Our geomorphic analysis of drainage basins suggests it indeed follows a boundary between tilting crustal blocks. Prompted by these results we acquired two reflection s-wave profiles across the lineament at prominent west-facing scarps at Porter Gap and Union City, Tennessee. At Porter Gap, where the lineament is the Chickasaw Bluffs, reflectors at 100–200 m depth dip west beneath the bluff face, and a steep reverse fault underlies the base of the bluff. Similarly, at Union City west-dipping reflectors beneath the scarp face appear truncated on the west near the base of the scarp, and auger data suggest a fault. Interestingly, structural relief at Porter Gap is higher on the east (consistent with topography), but separation on the fault is up-to-the-west. Thus, structure has been inverted during late Tertiary or Quaternary time.

INFLUENCE OF MINERALOGY AND GRAIN SIZE ON THE ELECTRON SPIN RESONANCE SIGNAL OF LOESS. ***David N. Lumsden and Aaron Broughton,*** *The University of Memphis, Memphis, Tennessee.* Electron spin resonance (ESR) can be used to determine absolute age. The ESR signal of loess is composite from quartz, feldspar, dolomite, and clay. The latter two are easily removed. Samples of quartz, microcline, and albite in five silt-size ranges were annealed at 250°C and then dosed with 2, 4, 8, 16, and 32 mrads of radiation from a Cobalt-60 source (total samples). Neither microcline nor albite showed ESR peaks for any grain size at any radiation level. The E' peak in the ESR spectrum of quartz increased in size and changed character upon annealing. After annealing the E' peak in coarse-silt samples behaved erratically as radiation was increased. The E' peak in fine-silt quartz systematically increased in size with increased radiation. The E' peak of quartz can potentially be used to determine the absolute age of loess.

PETROGRAPHY AND PETROCHEMISTRY OF LOWERMOST MIDDLE ORDOVICIAN CHERT IN THE VICINITY OF CHATTANOOGA, TENNESSEE. ***Habte Giorgis Churnet,*** *The University of Tennessee, Chattanooga, Chattanooga Tennessee.* Discrete nodules and clusters of chert of the Ponds Springs Formation, in the vicinity of Chattanooga, Tennessee, grew from centers outward. Carbonates and silica fill fractured rims of concentrically color-banded nodules. Chert, sparry dolomite, sparry calcite, malachite, and pyrite are present in rare brecciated pods. Cores of color-banded chert have more iron, whilst rims have more lime. Trace element composition in chert is very low, several being below detection limit, and much lower when compared to chert in other regions. Chert nodules are hosted in shallow marine carbonates. Yet, shale-normalized Cerium anomaly being less than 0.7 indicates that the nodules did not grow from continental shelf or shallow marine waters. Lack of a distinctive

negative Cerium anomaly precludes formation in ocean-basin or ocean-ridge environments. Thus, it is suggested that trace metals including REE were scavenged by metalliferous solutions and that the chert nodules were formed during a metallogenetic epoch.

HISTORY OF SCIENCE SECTION

BROTHER KEVIN RYAN, CHAIR

ACADEMY LEADERS: 1912–1936. *James X. Corgan, Austin Peay State University, Clarksville, Tennessee.* For the years 1912 through 1936, this study identifies leaders in the Tennessee Academy of Science. Twenty-two people served as president. Two died in office, one served two terms, and one served three. There were 23 vice-presidents, 11 editors, and five secretaries, treasurers, or secretary-treasurers. Forty-three officers led the Academy. A 44th leader organized the group but never held office. In a sense the Academy's most important leaders were George H. Ashley, Wilbur A. Nelson, and Charles H. Gordon. They managed two organizational sessions that preceded the first Academy meeting. Their roles are briefly discussed as are those of nine other notable leaders: L. C. Glenn, William E. Myer, Roscoe Nunn, Jesse M. Shaver, Asa A. Schaeffer, George R. Mayfield, John T. McGill, Jennette Moore King, and Albert F. Ganier. This study is based on Academy publications, the Academy's archives, the archives of the University of Tennessee, and the Vanderbilt archives.

THE VATICAN OBSERVATORY. ***Brother Kevin Ryan,*** *Christian Brothers University, Memphis, Tennessee.*
Abstract not available.

COSMIC ORIGINS. ***Brig Klyce,*** *Acorn Enterprises, Inc., Memphis, Tennessee.*
Abstract not available.

A HISTORY OF CITIZEN PARTICIPATION IN THE STUDY OF SEISMOLOGY. ***Charles A. Rond IV,*** *Center for Earthquake Research and Information (CERI), The University of Memphis, Memphis, Tennessee.* Amateur detection and recording of earthquakes was essentially an individual and dispersed effort in the US until an organization effort began a decade ago. Edward Cranswick, a geophysicist for the US Geological Survey, in October 1990, proposed a Public Seismic Network (PSN) of home computers in the seismically active San Francisco Bay area. Following his lead, a group of IBM engineers in San Jose established a computer Bulletin Board System (BBS) in 1991 to upload recorded data from their home computers linked to home-built seismographs. The author had constructed a similar home computer-linked seismograph, and with the addition of a BBS computer, established a PSN node in Memphis in March 1993. From there, the PSN has grown into a volunteer network of more than 50 seismic stations around the world, operating a dozen web sites, and posting their seismograms to the web site in Redwood City, California where they can be downloaded and viewed by the public five minutes later. The PSN assists students and amateurs with constructing their own sensing instruments, provides software to monitor the systems, and works with schools to encourage a greater interest in seismology, the earth sciences, and science and mathematics in general.

MATHEMATICS AND COMPUTER SCIENCE SECTION

FRANK HADLOCK, CHAIR

FREE CONVECTION FLOW PAST A VERTICAL PLATE I. ***Mohammed R. Karim,*** *Fisk University, Nashville, Tennessee.* In this paper we have investigated the combined effects of transpiration and free convection current on the unsteady flow of a viscous incompressible fluid past an exponential accelerated vertical permeable plate which is at a uniform temperature. Expressions for the velocity-field, temperature-field, and skin-friction are obtained in closed form by the Laplace transform technique. The effects of various physical parameters, for example, Grashof number, Prandtl number, transpiration parameter, etc. were discussed numerically. It is observed that for an isothermal plate the velocity profile increases due to greater cooling and decreases due to greater heating of the plate. We also observed, in the similar situation, that suction or injection through the porous surface of the plate causes a fall or rise in the velocity profile respectively.

CAS-AIDED CRYPTANALYSIS OF VIGENERE CIPHERS. ***Thomas H. Barr,*** *Rhodes College, Memphis, Tennessee.* A polyalphabetic cipher is a substitution cipher in which plaintext letters are replaced by cipher letters according to selection from various cipher alphabets. A special type, the Vigenere Cipher, uses a keyword to select the cipher alphabet, and it is generally difficult to break even for moderate length keywords. We utilize observations about letter distributions in the underlying plaintext, and we use a computer algebra system to recover the keyword from a given ciphertext.

WHEN REGULAR CLOSED SETS ARE SUPPORTS. ***John Schommer,*** *The University of Tennessee, Martin, Martin, Tennessee.* A regular closed set is any set that is equal to the closure of its interior. A support is a special kind of regular closed set: it is the closure of a cozero set. In spaces where every regular closed set is a support (rc = s), the distinction between topological properties like mild and meek normality or Oz and weak Oz disappear trivially. But spaces which enjoy rc = s need not be well behaved. We'll examine such spaces in this talk.

ADAMS SCHEMES WITH CONTINUOUS COEFFICIENTS FOR FIRST ORDER INITIAL VALUE PROBLEMS. ***Samuel Jator,*** *Austin Peay State University, Clarksville, Tennessee.* This paper is concerned with the derivation of a class of continuous Adams schemes for first order initial value problems (ivps) by the method of collocation. In this sense, we realize that the discrete Adams formulas are recovered from the continuous forms. It is noticed that the errors of the solution of the ivp in-between the grid points are of the same order as at the grid points for any sub-interval. The methods of higher order yield more accurate results in-between the grid points as well as at the grids. Actually, no extra work is needed for interpolation when solutions are obtained in-between the grid points. It also is observed that both the continuous and discrete solutions are equal at the grid points in general.

A MATHEMATICAL MODEL FOR ARMS CONTROL AND DISARMAMENT. ***Veronica A. Johnson and Mohammed R. Karim,*** *Fisk University, Nashville, Tennessee.* In this paper, we

tried to apply the applications of simple mathematics, especially that of differential equations, to some very interesting problems like arms control between two hypothetical, rival countries. To this end, we studied the Richardson's model of arms control and disarmament, which is a system of two differential equations. Using the techniques of differential equations we deduced the conditions under which either there would be a stabilized arms race, disarmament, or a runaway arms race. In order to clarify each of these cases, we also gave some examples.

A MATHEMATICAL MODEL FOR ARTERIAL PRESSURE. ***Mijiro Okobiah and Mohammed R. Karim,*** *Fisk University, Nashville, Tennessee.* In this paper, we built a model of arterial pressure using only the parameters that a physician would measure. The model is built for one cardiac cycle (from systolic to diastolic pressure) as a function of time (t). To build up the model we looked at the function of the heart and the mechanism of blood circulation. We also defined various terms and parameters and looked at their relationship to one another. From the relationships, we obtained a first order linear non-homogenous differential equation. The model is the result obtained by solving the differential equation. We also examined some medical conditions using the model. The predicted results were consistent with the measured results.

MATHEMATICS AND SCIENCE TEACHERS SECTION

JUDITH M. BONICAMP, CHAIR

WE HAVE SOLUTIONS: INSTRUMENT FEEDBACK HELPS QUANTITATIVE ANALYSIS STUDENTS LEARN TO MAKE DILUTIONS. ***Nyanguila Kakolesha*, Virginia Lee Mattie*, and Judith M. Bonicamp,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* One of the objectives of teaching improvement in chemistry is to prepare students to acquire cognitive thinking and investigative skills. The former is applied to the essence of becoming a trained chemist and the latter can be developed through laboratory experimentation. In quantitative volumetric analysis, mixing the solution well is critical to the success of an experiment because poorly mixed solutions will produce erroneous results. Students are briefed and instructed as to why care must be taken in proper rinsing and handling of the equipment in order to reduce contamination. Only after learning the technique are the students encouraged to compare their results with those from the standard solutions prepared and tested by an experienced instructor. After making solutions by serial dilutions, students use the spectrophotometer to measure the percent transmittance and the absorbance of their solutions in order to allow them to calculate concentrations, and the osmometer to measure the osmolality of the solution, which can be converted to molarity. The data recorded by the students from these instruments help them to immediately assess their triumph in solution making or their disappointment and decision to try one more time.

A CLASSROOM ACTIVITY ILLUSTRATING THE HARDY-WEINBERG PRINCIPLE. ***James R. Holden,*** *Nashville, Tennessee.* This presentation describes an activity, which promotes an understanding of the Hardy-Weinberg Principle. The Hardy-Weinberg Principle states the allele and genotype frequencies of populations will remain steady in large populations of randomly mating organisms not experiencing selection pressures, migration, or mutations. The Hardy-Weinberg Principle predicts these frequencies using a binomial expansion. Many students are intimidated when first exposed to the principle in mathematical terms. Students who are uncomfortable with the math are especially helped by the activity. During the exercise students use labeled index cards to simulate the gene pool. By recording and analyzing the allele and genotype frequencies through several generations, students can see the effects of meeting or violating the assumptions of the principle. Several variations of the activity will be discussed.

THE OLD MAN AND THE SHE: OR HOW A HIGH-SCHOOL STUDENT AND A RETIRED PROFESSOR DISCOVERED SCIENCE. ***Roy W. Clark and Kelly Lynn Martin*,*** *Middle Tennessee State University, Murfreesboro, Tennessee, and Washington University, Saint Louis, Missouri.* Thanks to the curiosity and imagination of a young high school student, she made a discovery, which we now call the Kelly Martin effect. Thanks to the experience and knowledge of an old professor working with this student, the discovery wasn't ignored. Instead, a scientific procedure was developed to test the usefulness of the Kelly Martin effect in identifying gases by their acoustic properties. The subsequent testing for reproducibility, and demonstration of the significance of the data gathered amply illustrated the scientific steps necessary to carry a discovery from interesting to scientifically useful.

A PROGRAM TO EDUCATE MIDDLE AND HIGH SCHOOL STUDENTS ABOUT ACQUIRED IMMUNODEFICIENCY SYNDROME. ***James Holden and Erik Prentice*,*** *Nashville, Tennessee, and Vanderbilt University Medical Center, Nashville, Tennessee.* The Vanderbilt University School of Medicine Acquired Immunodeficiency Syndrome (AIDS) Education Outreach Program was developed in 1996 to help increase knowledge of AIDS/Human Immunodeficiency Virus (HIV) and to provide adolescents with the tools to make informed decisions about behaviors which put them at risk for HIV infection. These tools include mechanisms for dealing with peer pressure and information regarding protection from HIV infection. The program in the middle and high schools consists of four sessions with the students. The sessions include interactive activities, small group discussions, and a presentation by an HIV positive individual. In order to improve the ability of the Vanderbilt students as facilitators, faculty and experienced peers conduct four training sessions. The training introduces the facilitators to the curriculum, promotes effective presentation and small group discussion skills, and ensures their knowledge of AIDS/HIV is current and accurate.

LOGIC BEHIND TEACHING MATHEMATICS TO BLIND STUDENTS. ***April Lynn Rice,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Have you ever thought about how you would describe a rainbow or a sunset without using any shapes or colors? How would you describe the solution to a maze without drawing a picture? How would you teach math to a blind student? Although the first two situations seem out of the ordinary, interaction with a blind student is an opportunity almost everyone will receive at least once. In a world filled with technology, much too often our blind students are still left in the dark. As teachers, we are responsible for teaching every person

in our class. Often, this includes students with a visual impairment. Blind students are special people, but it does not require a specialist to teach them. This presentation is intended to illustrate how important and rewarding teaching a blind student can be.

VISUAL AIDES IN TEACHING BLIND STUDENTS MATHEMATICS. ***Deborah Koning,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Many blind students do not have the chance to learn mathematics the way that sighted students do. Teachers often will exclude blind students from participation in an activity in mathematics due to the fact that the student cannot see the graphical representation. On the other hand, some teachers, although not excluding the student, do nothing to help the student see the representation of the problem. These teachers either feel there is no way possible for the blind students to "see" the graph or object, or they feel they do not have the time or the skills to draw the graph or object. If a teacher remembers that blind students see with their hands, then such obstacles can be overcome. Effective manipulatives to help them see can be made very cheaply and quickly. I will show the things I have made to teach the following ideas to blind students: geometric proofs; graphing, including graphing tangent lines and derivative functions; linear algebra, including matrices and their applications; and using Riemann sums to find the volume of solids of revolutions. This workshop is designed to show how a blind student can learn complex ideas through simple manipulatives.

POSSIBLY RUDOLPH'S PROOF: PYTHAGOREAN'S THEOREM. ***Al Ritter,*** *Memphis, Tennessee.* Given a square with side c abutted to the x and v axis and a being the distance from the origin to the vertex touching the x axis and b being the distance from the origin to the vertex touching the v axis, then the square of c is equal to the square of a and the square of b. From corners E and G construct lines parallel to the v-axis and from corners F and H construct lines parallel to the x-axis. The intersection of these lines at Points A, B, C, and D will be at right angles. Angles 1, 2, 3, 4, 5, and 6 are all equal. Angles 7, 8, 9, 11, 12, 13, 14, and 15 are all equal. Now by similar triangles FB = b and GB = a. DE and CH also equal a. Now BC = b—a. Along GI construct a point J at a distance b—a from vertex G. At J construct a line parallel to the x-axis intersecting GH at point M forming angle 10 which is equal to angle 11. Now "break off" triangle FGB and "fill in" the space formed by the origin and vertex's E and F. Similarly, triangle JGM can be placed in the space formed by vertex E and points K and I, which were intersected by the parallel emanating from G. These two triangles together with quadrilateral EFBK complete b square. Notice the square ONDE is "a square". The remaining pieces of c square, quadrilateral CJMH = quadrilateral ONLE and triangle KCH = triangle LDE completing a square.

MICROBIOLOGY SECTION

JOHN M. ZAMORA, CHAIR

POTENTIAL ROLE OF ANTIBACTERIAL SOAP IN ANTIBIOTIC RESISTANCE. ***Spence Dowlen*, Jacqueline Barnes*, and Stephen M. Wright,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Shortly after the discovery and therapeutic use of antibiotics, bacteria responded by developing resistance. There has been widespread concern with the growing use of antibacterial soaps and how they may impact bacterial resistance to antibiotics. Since the regular exposure of bacteria to antibacterial products could exert selective pressure on the population, we chose to evaluate if two exposures to antibacterial soap would lead to increased antibiotic resistance in *Staphylococcus aureus* and *Escherichia coli.* The antibiotics used were penicillin, cefaclor, tetracycline and triple sulfa. *E. coli* did not show a measurable change in resistance to any of the antibiotics following exposure to antibacterial soap. However, *S. aureus* demonstrated a significant change in resistance patterns to both penicillin and triple sulfa. According to the Kirby-Bauer standard resistance table, pre-soap *S. aureus* was susceptible to both penicillin and triple sulfa. After selective exposure to antibacterial soap, *S. aureus* was resistant to both antibiotics.

AN ENDOSPORE-FORMING BACILLUS EXHIBITING GLIDING MOTILITY. ***Timothy Fusco* and Stephen M. Wright,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Only a fraction of bacteria have been described and greater than 99% of environmental organisms remain nonculturable in the laboratory. This report details an unusual environmental isolate which does not fit well into current taxonomic groupings. A gram variable, endospore forming, facultatively anaerobic, flagellated bacillus was isolated from a sample of surface soil. When plated, the organism exhibits a unique form of motility and colony formation. This gliding motility enables the organism to move freely across an agar surface. Within six hours of inoculation the organism has moved and formed micro-colonies, and within ten hours macro-colonies and endospores have formed. It is believed that this organism falls into the genus *Bacillus.* However standard laboratory diagnostic methods, including BBL Crystal identification system, have failed to definitively characterize the organism. We report results from laboratory testing. However, actual classification awaits 16 S sequencing and phylogenetic analysis.

ISOLATION AND IDENTIFICATION OF CELLULOSE-DEGRADING MICROORGANISMS. ***Lori Ray* and John Zamora,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Cellulose and products made from cellulose are major constituents of landfills today. Paper mills also have disposal problems with byproducts from the paper making process. The purpose of this study was to isolate and identify efficient cellulose-degrading organisms. Soil and paper mill samples were isolated from thermophilic cellulose agar and minimal salts agar containing cellulose. Several laboratory strains of organisms were plated onto the thermophilic cellulose agar and the minimal salts cellulose agar to determine the selectivity of the media. The most efficient cellulose-degraders were determined using biometry (CO_2 evolution).

ISOLATION OF *SHIGELLA* PHAGE FROM RAW SEWAGE SAMPLES. ***Curtis Scott* and John Zamora,*** *Middle Tennessee State University, Murfreesboro, Tennessee. Shigella* spp. Are pathogens associated with gastrointestinal distress. Raw food, contaminated water, and poor hygiene are responsible for the spread of *Shigella.* Although the genus is considered fragile, as few as 100 organisms can lead to infection. The isolation and identification of *Shigella* from environmental samples is difficult. The goal of this study is to isolate bacteriophages specific for *Shigella.* Viruses are obligate intracellular parasites and require the presence of a specific host for replication. Viruses should be

found in many of the same locations as the host. Sewage samples from five wastewater treatment plants were collected and filtered. The filtrates were tested against *Shigella sonnei, Shigella boydii,* and *Shigella flexnerii* for plaque production. Plaques were quantified. Specific virus isolates were amplified. After amplification, phage typing was performed with each of the isolates.

EFFECT OF TEMPERATURE ON THE IMMUNE RESPONSE OF WESTERN RIBBON SNAKES (*THAMNOPHIS PROXIMUS RUBRILINEATUS*). ***Daniel Ray French* and Don Dailey,*** *Austin Peay State University, Clarksville, Tennessee.* Specific host defenses of poikilothermic animals have been suggested to be temperature dependent. Antibody production is diminished in these animals during hibernation. The purpose of this study was to provide information on the effects of temperature on the humoral immune response of red ribbon snakes (*Thamnophis proximus rubrilineatus*). Snakes were challenged with *Aeromonas hydrophila* and incubated at 22, 25, 30, and 35°C. After a 28-day incubation period, blood was collected and assayed for antibodies against the bacterium. All snakes, with the exception of one, had antibody titers of at least 1:4, which suggests an active infection. Blood samples also were collected and cultured for *Aeromonas hydrophila.* Interestingly, the bacterium was isolated from the challenged snakes as well as unchallenged control snakes.

PHYSICS AND ASTONOMY SECTION

PATRICIA G. HULL, CHAIR

THERMOLUMINESCENCE IN THERMALLY QUENCHED ULTRA HIGH MOLECULAR WEIGHT POLYETHYLENE. ***Scott Lewis* and M. S. Jahan,*** *The University of Memphis, Memphis, Tennessee.* Ultra-high molecular weight polyethylene (UHMWPE) used in total hip and joint replacement has been found to contain free radicals. The free radicals are formed after gamma sterilization and subsequently cause degradation of the UHMWPE through oxidation. Thermally annealing free radicals in a process referred to as thermal quenching is a potential method of preventing oxidation in this biomaterial. In this study, thermally stimulated technique (TL) is used to investigate thermal stability of free radicals/trapped charges in three different industrial grade UHMWPE's. Following X-irradiation and subsequent heating in the temperature interval 23–200°C, TL glow curves produced characteristic emissions near 75°C and 100°C from the crystalline and amorphous regions, respectively. Subtle differences between these types of UHMWPE will be discussed.

POSSIBLE 3-D STRUCTURE IN A PYRAMIDIC LIQUID CRYSTAL. ***M. Sarkar and N. Spielberg,*** *Tennessee State University, Nashville, Tennessee, and Kent State University, Kent, Ohio.* All of the compounds of hexaalkanoyloxytribenzocyclononene series (II-*n*) exhibit columnar mesophases. The mesophase structure of pyramidic columnar liquid crystal II-9 is being investigated by X-ray powder transmission diffractometry. For $n = 9$ the transition temperature between the solid and the mesophase is 26°C, and between the mesophase and the liquid phase is 152°C. Data previously collected in the lower temperature portion of the columnar phase have suggested that this particular compound exhibits some three-dimensional order, in that at least four high angle diffraction lines are superposed on the usual broad hump. We have extended the temperature range of the measurements well into the mesophase to see to what extent this purported order is maintained.

NEW RIGOROUS RESULTS FOR THE CORRELATED RANDOM WALK IN ONE DIMENSION. ***Donald R. Franceschetti and John W. Hanneken,*** *The University of Memphis, Memphis, Tennessee.* An exact expression has been obtained for the distribution of random walkers after any number of steps with a fixed bias to persist in the direction of the previous step. The solution allows for an arbitrary choice of first step direction. Exact expressions also are obtained for the first and second moment of the distribution and the apparent diffusion coefficient. The result is related to the Ising model and to results obtained for nonclassical diffusion obeying a diffusion equation of fractional order in time.

THE EQUILIBRIUM PROBLEM IN MOLECULAR COMPUTING. ***Donald R. Franceschetti,*** *The University of Memphis, Memphis, Tennessee.* "DNA computing" involves the translation of hard computational problems into ensembles of DNA molecules, which effectively compute a molecular representation of the solution to the problem in a massively parallel fashion. Extraction of the solution frequently involves the sorting of DNA strands by molecular weight using electrophoresis. The effectiveness of the computational scheme is thus degraded if the polymerization produces strands longer than those needed for the problem solution. A simple equilibrium calculation provides a guideline for the average length of polymer to be expected in the type of diverse ensemble of DNA molecules employed in solving combinatorial problems expressed in DNA.

RESEARCH AND EDUCATION AT THE NASA/FISK UNIVERSITY CENTER FOR PHOTONIC MATERIALS AND DEVICES. ***Enrique Silberman,*** *Fisk University, Nashville, Tennessee.* In 1992, NASA awarded Fisk University a 10 year grant to establish a center for research and education on photonic materials and devices. Presently, materials are synthesized, characterized, and in some cases, developed into devices with applications in the fields of radiation detectors and non-linear optical crystals, glasses, and nanomaterials. The educational components include participation in the research by 3 types of students majoring in Physics, Chemistry, and Biology: 1) Fisk undergraduates participating during the academic year, 2) Fisk graduates performing their Master Thesis research, and 3) Fisk and other HBCU's and minority institutions' undergraduates attending a 10-week summer workshop with a very rigorous program of study, research, and progress reporting. Funds are available for supporting participating students. Prerequisites, schedules of activities, evaluation procedures, and typical examples of the outcome are presented.

DO WE NEED TO CORRECT REDSHIFT OBSERVATIONS? ***Nabil W. Wakid,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Intergalactic space is believed to consist of a collisionless plasma mostly of hydrogen. With the huge distances between us and luminous objects in outer space, the amount of intervening plasma can become quite significant even at very low densities. It has been tacitly assumed so far that such intergalactic plasma has a negligible effect on light reaching us from distant objects. Because electromagnetic waves are known to interact with orbiting electrons at a wide range of frequencies, it is conceivable they also would interact with free electrons. Such inter-

action may result in annihilation of the striking photon or in a loss of part of its energy without necessarily changing its direction. The result would be a redshift. Thus the observed redshift of distant galaxies could be $z = (\Delta\lambda_d + \Delta\lambda_p)/\lambda$, where $\Delta\lambda_d$ is the shift in wavelength due to the Doppler effect and $\Delta\lambda_p$ is the shift due to intervening plasma. Verification of this hypothesis would require spectral shift observations of a star seen through the sun's corona during an eclipse.

OPTICAL WHISPERING-GALLERY MODE IN LIQUID SPHERES. ***Ling Jun Wang and Robert Shaw,*** *The University of Tennessee, Chattanooga, Chattanooga, Tennessee, and Oak Ridge National Laboratory, Oak Ridge, Tennessee.* Optical pulse propagation in whispering-gallery modes of liquid spheres has been studied in the time domain. It has been found that the evanescent field absorption has little effect on these modes. The methods for achieving whispering-gallery modes in liquids, which can be used for absorption spectroscopy of weak absorbents, are explored. The ring-down signal of such mode, which is generated by a pica-second infrared light pulse of a Ti-sapphire laser with a wavelength of 795 nm, is presented. The issue of coupling efficiency with an optical fiber coupler also is discussed.

DETERMINATION OF FIBER ORIENTATION IN PAPER USING POLARIZED LIGHT SCATTERING. ***Patricia G. Hull, Thomas Mason, Mary Quinby-Hunt, and Arlon Hunt,*** *Tennessee State University, Nashville, Tennessee (PGH, TM), and Lawrence Berkeley National Laboratory, Berkeley, California (MQH, AH).* The purpose of this project is to demonstrate that polarized light scattering can be used to rapidly and non-destructively measure the distribution function of fibers in paper as the paper is being made. Since the overall quality of paper is a function of fiber orientation, it is important to monitor the orientation during the paper-production process, allowing operators to alter conditions if necessary to keep fibers within desired alignment parameters. Initial measurements of the light scattering were made for a paper sample fixed in the instrument rather than during production in order to test the theory. It was determined that a linear combination of two Mueller matrix elements was most sensitive to the fiber orientation. It was evident that polarized light scattering is indeed an effective technique of on-line measurement of the orientation of the fibers in paper.

TIRED-LIGHT REDSHIFTS OF EXTRAGALACTIC OBJECTS. ***Jennifer Evans* and Jaime Taylor,*** *Austin Peay State University, Clarksville, Tennessee.* The most widely accepted cosmological model is that of an expanding universe originating from the big bang. Despite the acceptance of the Doppler redshift described by Hubble's law, there are problems with this model. Recently, tired-light models have arisen to explain the observed redshift. Tired-light models theorize photon energy loss, thus a redshift, due to various physical mechanisms, and thus eliminate the need for an expanding universe. One such tired-light model was examined by plotting the predicted number of objects vs. redshift, and comparing the result with redshift data.

DETERMINATION OF FIBER ORIENTATION IN PAPER. ***Thomas Mason*, Patricia G. Hull, M. Quinby-Hunt, and Arlon Hunt,*** *Tennessee State University, Nashville, Tennessee (TM, PGH), and Lawrence Berkeley National Laboratory, Berkley, California (MQH, AH).* A large fraction of fibers in mechanically manufactured papers tend to be oriented in one of two directions, either parallel or perpendicular to the direction of the movement of the paper during the manufacturing process. During this process the fibers also can lose this orientation, which in turn affects the overall quality of the paper being produced. We modified an existing instrument for light scattering measurements to monitor the orientation of the fibers in a paper sample fixed in the instrument. The paper was rotated and measurements of light scattering were made as a function of paper angle for five different kinds of paper to verify our theory. The most sensitive Mueller scattering matrix element, the best scattering angle, and the best angle of incidence on the paper were determined. An instrument for fast and efficient determination of the fiber orientation during paper production is under consideration.

ZOOLOGY SECTION

RAY JORDAN, CHAIR

SECONDARY PRODUCTIVITY OF MACROARTHROPODS IN A MINED AND AN UNMINED STREAM IN THE CUMBERLAND MOUNTAINS OF EASTERN TENNESSEE. ***Joseph R. Schiller,*** *Austin Peay State University, Clarksville, Tennessee.* Secondary productivity of the 20 most abundant macroarthropod taxa was estimated in two second order Cumberland mountain streams using the size-frequency method. One stream was relatively pristine and had no prior history of surface mining for coal in its watershed. The other stream had experienced surface mining in approximately three percent of the surface area of its watershed. Secondary productivity was significantly different between streams for 16 of the taxa. The pristine stream had higher secondary productivity for collector-gatherer, predator, and scrapper functional feeding groups while the surface mined stream had higher secondary productivity in the collector-filterer and shredder functional feeding groups. These results are consistent with earlier studies showing that scrapers and collector-gatherers are significantly reduced for decades in streams where surface mining of coal has occurred. The shredder functional feeding group was much more productive in the mined stream and this is consistent with the larger CPOM input measured for this stream. The mined stream also had a higher total secondary productivity than the pristine stream. This result may be an artifact reflecting the fact that the estimate of secondary productivity in the mined stream included a larger proportion of its total fauna compared to the pristine stream because the pristine stream had a more diverse fauna and more rare species that were not sufficiently abundant to include in an estimate of secondary productivity.

FACTORS ASSOCIATED WITH SURVIVAL IN A TRANSLOCATION EXPERIMENT OF COTTON RATS *SIGMODON HISPIDUS*. ***James R. Holden,*** *Nashville, Tennessee.*
Abstract not available.

METAMORPHOSIS OF *UTTERBACKIA IMBICILIS* GLOCHIDIA ON BLUEGILL SUNFISH IN STREAM WATER VERSUS CONTROL WATER. ***Amy Cline and Joseph R. Schiller,*** *Austin Peay State University, Clarksville, Tennessee.* Seventy percent of the approximately 300 species of Native Freshwater mussels in the United States are extinct, endangered, threatened, or of special concern, Therefore, freshwater mussels are one of the most endangered groups of organisms on earth. This research

project studies the early life stages of freshwater mussels and how they are affected by pollution. The larva of freshwater mussels is an obligate parasite on freshwater fishes. This larva must attach and encyst on a host fish where it transforms into a juvenile mussel, which is released to complete its life cycle as a free-living organism. We will use the mussel *Utterbackia imbecillis,* which parasitizes the common bluegill sunfish, *Lepomis macrochirus.* The ability of glochidia of this mussel to attach, encyst, and successfully transform to the juvenile stage will be compared in control versus stream water. Stream water will be obtained from Sulfur Fork creek in Robertson County Tennessee, a stream known to be affected by non-point source pollution.

EFFECTS OF TEMPERATURE AND BODY MASS ON RESTING METABOLISM IN THE PLETHODONTID SALAMANDER, *EURYCEA JUNALUSKA.* ***Craig D. Wilmhoff, W. Russ McClain, and William H. N. Gutzke,*** *The University of Memphis, Memphis, Tennessee.* The effect of temperature on resting metabolism in an aquatic environment was examined in adults and larvae of the plethodontid salamander, *Eurycea junaluska.* Adults exhibit a curvilinear increase in resting metabolic rate with increasing temperature whereas larvae exhibit a linear increase in resting metabolic rate with increasing temperature. Adults exhibit a significantly higher resting metabolic rate than larvae at 20°C and 25°C. This difference in resting metabolic rate between adults and larvae at higher temperatures coupled with the "insensitivity" to temperature change exhibited by larvae between 0°C and 20°C indicates that possessing a larval stage of development may be beneficial to *E. junaluska* by decreasing maintenance costs. Body mass exhibited a significant effect on resting metabolism in both adults and larvae.

SOCIAL AND REPRODUCTIVE BIOLOGY OF THE PRAIRIE VOLE: TESTING OF ALTERNATIVE HYPOTHESES. ***Aimee Dunlap-Lehtilä and Jerry O. Wolff,*** *The University of Memphis, Memphis, Tennessee.* Numerous studies from the laboratory and field have concluded that prairie voles, *Microtus ochrogaster,* are socially monogamous. These conclusions are based primarily on long-term associations between males and females, formation and maintenance of pairbonds, and paternal behavior. In a series of laboratory experiments in which we gave 31 unpaired females a choice of three males, 7 (23%) females mated will all three males, 11 (35%) mated with two males, and 13 (42%) mated with one male. Females showed a preference for one male as indicated by amount of time spent together, but 58% of females mated promiscuously with one or two other males. These results are comparable to those observed in a similar study with the promiscuous meadow vole *Microtus pennsylvanicus.* When paired females that had just given birth were presented with a choice of their current mate or two strange males, 10 of 16 females mated with at least one of the strange males. Thus, given the opportunity, pair-bonded females also exhibited multi-male mating. We propose the apparent pairbond formed by male prairie voles is an attempt to mate-guard to insure paternity. This is necessary because, given the opportunity, females will seek extra-pair copulations. We are currently conducting experiments to discern among alternative hypotheses for the function of multi-male mating by female prairie voles and other mammals.

CLUTCH SIZE IN CAROLINA CHICKADEES. ***T. David Pitts,*** *The University of Tennessee, Martin, Martin, Tennessee.* Carolina Chickadees (*Poecile carolinensis*) are small (body mass of approximately 10 g), cavity-nesting birds that are permanent residents in Tennessee woodlands. Each female chickadee typically lays only one clutch of eggs per year. In northwestern Tennessee where I have studied Carolina Chickadees since 1970, the earliest clutches are initiated in March and the latest clutches are laid in May; the peak of egg laying typically occurs in late March and early April. Clutches in Tennessee range in size from 2–8 eggs. Both mean clutch size and maximum clutch size increase from south to north across the range of Carolina Chickadees, which includes 20+ states in the southeastern part of the United States. Within each nesting season, clutch size and laying date are inversely related. Unlike some other species of parids, nest cavity size has not been shown to significantly affect clutch size in Carolina Chickadees. Approximately 60% of the females that nested in more than one year laid clutches of the same size each year. All of the clutches of 8, the largest clutches observed, were laid during 1978–1983, the six-year period with the coldest winters that occurred during my study.