College of Natural Sciences and Mathematics

10th Annual Student Research Symposium

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Biology

Does Early Exposure to Pain Alter Brain Function?

Brian Bowden, Julie Carter, Jason Fechter, Danny Glassman, Amanda Plummer, Debbie Soellner, Kate Street, and John Frank Faculty Mentor: Barbara Clancy

Distribution and Connectivity Patterns of Persisting Cortical Subplate Cells in Aging Swiss Webster Mice

Jason Fechter, Bowman, B., Hyde, J., Isbell, S., Palmer, S. and Seballos, P. Faculty Mentor: Barbara Clancy

Acidification induced exocytic response in MCF-7 cells and correlating apoptosis

U. B. Haley Faculty Mentor: Steve Runge

Role of Pedal Three Neuron in turning of Tritonia diomedea

Joshua Morrison Faculty Mentor: James Murray

Proximate cue or ultimate cause: Why does myristicin trigger trenching?

Ken Pigue Faculty Mentor: David Dussourd

Predicting the timing of neural and visual development across mammalian and non-mammalian species

Julie Staudinger, Danny Glassmann, and Jessica Harrison Faculty Mentor: Barbara Clancy

Identification of the regulatory proteins controlling intracellular pH in cultured human breast cancer cells

Brandon Walser and Dana Strassle Faculty Mentor: Steven W. Runge

Increased habitat heterogeneity: effects on macroinvertebrate biomass and distribution patterns in a shallow eutrophic reservoir

Bradley S. Williams Faculty Mentor: Joseph Shostell (Penn State Fayette)

Chemistry

Chemical Switches: State-Specificity in the Gas Phase Reactions of Cu⁺, Ag⁺, and Au⁺ with Halogenated Methanes *Cullen C. Matthews and Kristin S. Parkhill Faculty Mentor: William S. Taylor*

Computer Science

Computational Study of a Wire Tension Problem at Tokusen USA Sze-Huan Chin

Faculty Mentor: Chenyi Hu

Automated Robot Guidance through Sonar Navigation and Color Recognition

Chad Miller, Josh Hight, Justin Michaels Faculty Mentor: Han-Chieh Wei

Improving Efficiency for Latent Semantic Indexing of Large Dynamic Document Collections

Benjamin Severs Faculty Mentor: Chenyi Hu

Mathematics

Parametric Symmetries of Ordinary Differential Equations

Yousuf Abbasi Faculty Mentor: Danny Arrigo

Symmetry Analysis of the One-Dimensional Heat Equation with Variable Diffusivity

Joel Harris Faculty Mentor: Danny Arrigo

Multigrid Numerical Solver

Garth Johnson Faculty Mentor: Irene Livshits

Physics and Astronomy

Spectroscopic Observations of a Nova Outburst and Be Stars *Bart Dunlap*

Faculty Mentor: Scott Austin

Particle Induced x-ray emission experiments (PIXE) to determine sample elemental composition and unknown sample thicknesses

C. Eric Easton and Chris A. McNeill Faculty Mentor: Rahul Mehta and Stephen R. Addison

Rutherford and Non-Rutherford Scattering of 1.5 MeV Protons by ₂₈Ni, ₆C, and ₈O Targets

Jason House and Bart Dunlap Faculty Mentor: Rahul Mehta and Stephen R. Addison

Acoustic Properties of Porous Materials

Chris McNeill Faculty Mentor: Carl Frederickson

Kinematics in Rutherford Scattering

Scott Sullivan and Angela Roper Faculty Mentor: Rahul Mehta and Stephen R. Addison*

ABSTRACTS

BIOLOGY

Does Early Exposure to Pain Alter Brain Function?

Brian Bowden, Julie Carter, Jason Fechter, Danny Glassman, Amanda Plummer, Debbie Soellner, Kate Street, and John Frank Faculty Mentor: Barbara Clancy

Children born prematurely often have long term cognitive and behavioral problems indicating a disruption in brain function. It is suspected that these problems are associated not with premature birth itself but with the pain experienced during lifesaving and routine procedures which are often performed without anesthesia. We hypothesize that when neonatal mammals are exposed to pain without anesthesia the structure of the brain itself is altered a disruption that can be minimized if anesthesia is administered for an appropriate time period The overall goal of this study is to better understand how pain and or anesthesia in newborns might affect the way the brain develops with a focus on an area of the brain called the cortex Previous research indicates rats exposed to neonatal pain develop problems similar to those experienced by expreterm humans We are the behavior of rats that have undergone painful neonatal experiences with analvzing and without anesthetic drugs and the brain of the same animals including the structure of the cortex in treated and control animal groups Using these data we will begin to understand how brain disruption may be associated with developmental disorders often seen in children who were born prematurely

Distribution and Connectivity Patterns of Persisting Cortical Subplate Cells in Aging Swiss Webster Mice

Jason Fechter, Bowman, B., Hyde, J., Isbell, S., Palmer, S., and Seballos, P. Faculty Mentor: Barbara Clancy

The mammalian cortex is a thin layer of neurons that covers the exterior of the brain and matures above the subplate Subplate neurons are typically identified by their characteristic position subjacent to the cortex morphological and labeling patterns and early cell death Subplate neurons play an important role in cortical development but little is known about a subset that persists through maturation We labeled subplate cells in a mouse model Swiss Webster using retrograde fluorescent tracer deposits in motor somatosensory and visual cortices including deposits restricted to cortical layer I Our data suggest that the distribution and connectivity patterns of persisting subplate cells remain stable across normal adulthood 6 wks[^] mos although patterns vary slightly based on cortical location Advanced aging > 8 mos may reduce labeling of subplate

cells but whether this is due to altered connectivity reduced cell numbers or reduced subplate function remains to be studied

Acidification induced exocytic response in MCF-7 cells and correlating apoptosis

U.B. Haley Faculty Mentor: Steve Runge

The interior of solid tumors has poor vascularization resulting in an extracellular environment with a pH below normal This low pH is due principally to the build up of metabolic waste An acidic extracellular environment can instigate the build up of intracellular H that can induce apoptosis Cell survival in this environment requires the use of additional pH regulatory mechanisms to prevent apoptosis A growing number of studies have revealed vesicular trafficking as a method of regulating the activity of transporters in the cell membrane

Our research indicates that intra and extracellular acidification stimulates vesicular trafficking in cultured human breast cancer MCF 7 cells Potential roles of microtubules and actin filaments in stimulated vesicular trafficking and the correlation between apoptosis and ability to exocytose will be investigated

Role of Pedal Three Neuron in turning of *Tritonia diomedea*

Joshua Morrison Faculty Mentor: James Murray

Our research focuses on the sea slug *Tritonia diomedea* Specifically we will study the Pedal Pd neuron This neuron is responsible for foot movement of the animal Firing of Pd causes the animal to contract its foot We will use microelectrodes and intracellular recording techniques to study Pd We will stimulate the foot with variable currents in order to elicit a response We will use video camcorders to capture the animals movement of the foot By comparing the video with our electrophysiology data we will be able to determine velocity of foot movement area of foot moved and time to rest Knowing this will allow us to see how Pd interacts with other neurons in performing natural behaviors such as turning towards the direction of water flow approaching prey and escaping predators

Proximate cue or ultimate cause: Why does myristicin trigger trenching?

Ken Pigue

Faculty Mentor: David Dussourd

Caterpillars of the cabbage looper *Trichoplusia ni* often cut trenches across leaves thereby deactivating defensive canals and reducing larval exposure to plant exudates such as latex or resin Previous work has identified myristicin a phenylpropanoid found in parsley as a chemical elicitor of trenching We sought to test if myristicin is poisonous for cabbage loopers If so trenching could function specifically to reduce larval exposure to myristicin Our approach is to inject ml of water or myristicin into the guts of narcotized loopers We will record the time until loopers resume feeding pupal weight and survival to adult stage Initial results suggest that loopers require longer to recover after receiving myristicin This study is the first to test the toxicity of a chemical stimulant of trenching

Predicting the timing of neural and visual development across mammalian and non-mammalian species

Julie Staudinger, Danny Glassmann, and Jessica Harrison Faculty Mentor: Barbara Clancy

A mathematical model originally derived to study evolutionary change in the developing mammalian nervous system has also proved useful in predicting the timing of neural development including the development of human infants Clancy et al Neuroscience : 7 7 The model predicts aspects of neurogenesis and axonal

Apoptosis or programmed cell death is an essential mechanism for the development and

influence the benthic macroinvertebrate community by providing nutrients sediment stability refuge from predators oxygen and increased niche space

CHEMISTRY

Chemical Switches: State-Specificity in the Gas Phase Reactions of Cu⁺, Ag⁺, and Au⁺ with Halogenated Methanes

Cullen C. Matthews and Kristin S. Parkhill Faculty Mentor: William S. Taylor

Numerous studies have illustrated that the outcomes of reactions of bare transition metal ions can be dramatically influenced by the electronic state of the metal often to the extent that certain states become unreactive regardless of favorable energetics for a given product channel A frequently cited goal of research into transition metal ion chemistry is somehow to exploit this sensitivity in order to control product formation Research focusing primarily on first row ions has illustrated that state specificity can be successfully rationalized within the framework of conservation of electron spin; however significant spin orbit coupling in second and third row ions makes the exclusive use of spin as a predictive tool less certain Indeed comparatively few studies have been reported in which the spin states of heavy ions have been definitively specified Previous studies by other researchers have reported that Au participates in sigma bond activation in halomethanes but the electronic state specificity has not been ascertained We have previously examined the reactions of Au and Cu in both the S ground state and the D first excited state with CH Br in which the outcomes are consistent with both the known thermochemistry and overall conservation of spin In the work described here the reactions of SDCu SAg and SDAu with CHCICHCIF CHCIF and CF CI Our objectives are to evaluate differences in product formation from the two states for each metal and to assess the applicability of the spin rule with respect to the behavior of Ag and Au

COMPUTER SCIENCE

Computational Study of a Wire Tension Problem at Tokusen USA

Sze-Huan Chin Faculty Mentor: Chenyi Hu

In this project we study and analyze the behavior of a wire path on a wire bunchier machine at Tokusen USA Inc The function of the machine is to joint two wires together

When the binding process begins two wires from different rods at the same side are combining together through rotating exercise. The binding wire behaves like a jump rope with two fixed points at each side of the machine. We are looking for the mathematical model and computational methods of the wire path in this specific application problem. By analyzing the tension of the wire and other conditions we established a model of nonlinear ordinary differential equation with Dirichlet boundary condition. Then we solve it computationally with shooting and collocation methods. We found reasonable numerical approximations for the problem.

Automated Robot Guidance through Sonar Navigation and Color Recognition

Chad Miller, Josh Hight and Justin Michaels Faculty Mentor: Han-Chieh Wei

Our preliminary research into robotics focused upon creating an application that utilizes the robot's existing sonar and contact sensors in correlation with the vision sensor we

Latent Semantic Indexing LSI is a process that used to index document collections by topic as an addition to keyword or other method. It can also be used to perform a query on a collection of documents to find the documents that are most relevant to the query based on topic. In dealing with large dynamic document collections LSI can be very time consuming. In this project, we report our investigation on how to reduce the time and computational costs associated with performing LSI on a large dataset by segmenting the dataset into smaller subsets within tolerable accuracy difference.

MATHEMATICS

Parametric Symmetries of Ordinary Differential Equations

Yousuf Abbasi Faculty Mentor: Danny Arrigo

The method of symmetry analysis of ordinary differential equations ODEs was first introduced by Sophus Lie in 88 as a method to unify the seemingly unrelated techniques in solving ODEs. It is well known that if a nonlinear second order ODE admits an 8 parameter Lie group of symmetries it can be transformed into a linear second order ODE.

If the ODE fails to admit an 8 parameter family of symmetries it is still sometimes possible to linearize the equation We will show that if both independent and dependent variables in the equation are parametrized a second equation can be chosen for completeness as the new system admits an 8 parameter family of symmetries thereby indicating linearization

Symmetry Analysis of the One-Dimensional Heat Equation with Variable Diffusivity

Joel Harris Faculty Mentor: Danny Arrigo

Symmetry methods can typically be used to find exact solutions to complicated partial differential equations While there are standard methods for solving the one dimensional heat equation without a source term and with constant diffusivity the problem becomes much more complicated when one or both of these are included Previous work involved

a change of variables from a heat equation of the form ()

scattering chamber The particle beam knocked electrons out of their occupied energy shells and as higher energy shell electrons fell in to replace those knocked out energy was released in the form of x rays The x rays were detected and analyzed for their energy level which was then compared to known x ray energies thus allowing for the identification of the target elements The change in x ray energy from two samples one of known thickness and one of unknown thickness of the same element can be used to determine the thickness of unknown sample We also acknowledge the assistance of Dr Jerome L Duggan and Dr Fabian Naab of the University of North Texas

Rutherford and Non-Rutherford Scattering of 1.5 MeV Protons by ₂₈Ni, ₆C, and ₈O Targets

Jason House and Bart Dunlap Faculty Mentors: Rahul Mehta and Stephen R. Addison

Scattering behavior of protons incident on ₈Ni ₆C and ₈O targets is experimentally investigated A Van de Graaff accelerator is used to accelerate protons to MeV After colliding with the target they are deflected at various angles where a particle detector measures the yield of scattered protons per number of incident protons. These measurements are compared with those resulting from theoretical Rutherford scattering calculations. It is observed that at high angles the scattering from ₆C and ₈O targets exhibits non Rutherford behavior while ₈Ni displays Rutherford scattering at all angles. We also acknowledge the assistance of Dr. Jerome L. Duggan and Dr. Fabian Naab of

the University of North Texas

Acoustic Properties of Porous Materials

Chris McNeill Faculty Mentor: Carl Frederickson

The porous properties of materials are important in outdoor sound propagation noise suppression and other areas of interest Controlled laboratory measurements of the porous properties of powder like glass beads have been made using acoustical means The characteristic acoustic impedance and the acoustic propagation constant of unconsolidated glass beads can be determined from acoustical measurements made from an impedance tube Models for the acoustic properties of porous materials are used to determine the porous properties of the glass beads. Future research will include making non acoustic measurements of flow resistively on the same samples that are used in the impedance tube in order to compare the acoustic and non acoustic determination of porous properties.

Kinematics in Rutherford Scattering

Scott Sullivan and Angela Roper Faculty Mentors: Rahul Mehta and Stephen R. Addison*

Particle scattering was investigated for energetic alpha particles on different element sample targets originating from a MeV Van de Graff accelerator at the University of North Texas A variable magnetic field allowed the selection of the alpha beam article initial energies to be MeV and MeV The energetic incident alpha particles struck the element targets and scattered These scattered particle energies were detected and measured at an angle of ^o We formed a ratio between the incident beam energy and the scattered particle energy and compared it with the values calculated from the theoretical kinematical scattering factor The theoretical kinematical scattering factor was derived tweclatedsas derivedwj ET wo7Q factor