



**SCHOOL OF SCIENCE AND
MATHEMATICS**

**Student Research
Poster Display**

Caputo Hall Lobby

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- BIOLOGY •
- CHEMISTRY •
- EARTH SCIENCES •
- NURSING •
- PHYSICS •

Table of Contents

	Abstract Number
Biology.....	1 - 4
Chemistry.....	5
Earth Sciences.....	6
Nursing.....	7
Physics.....	8 - 13
Index of Authors.....	i - ii

Note: The names of Millersville University faculty advisors are designated by an asterisk (*) in the abstracts.

Biology

1. Identification of Areas Baited for *Odocoileus virginianus* using Chemical Analysis.

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Supplemental feeding and baiting of white-tailed deer (*Odocoileus virginianus*) has the potential to increase the spread of diseases such as Chronic Wasting Disease. Also, the baiting of wildlife for harvest is illegal in the state of Pennsylvania. The objective of this study was to determine if commercial deer baits leave a chemical signature in the soil that is detectable through chemical analysis. This information could then be used by conservation officers to determine if an area has had illegal baiting activity. Commercial deer baits were applied to experimental soil patches and compared to non-baited control soil patches. It was hypothesized that baited areas would exhibit elevated concentrations of calcium and sodium compared to non-baited soil. Atomic absorption spectroscopy was used to measure the concentration of sodium and calcium ions present in control and baited soils. Tentative results indicate that calcium is not an adequate indicator for baiting activity. Results also suggest that elevated levels of sodium are detectable in the baited areas. Therefore, detection of elevated levels of sodium could be used to determine if an area has been baited.

2. Insight into the Evolutionary Relationship between Short-chain Isoprenyl Diphosphate Synthases, Terpene Synthases and Triterpene synthases.

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Short-chain isoprenyl diphosphate synthases (IDS), members of prenyltransferases, catalyze the synthesis of the key intermediates for the biosynthesis of various terpenes. Terpene synthases (TPS) catalyze the synthesis of monoterpenes, sesquiterpenes and diterpenes, while triterpene synthases (TTPS) synthesize triterpenes. So far the evolutionary/phylogenetic relationship between these three mechanistically related families remain unclear. Also unclear is the evolutionary relationship of plant and microbial IDS, TPS and TTPS. A genome-wide identification of IDS, TPS and TTPS genes, their detailed structural analysis and chromosomal localization/gene clustering as well as phylogenetic analysis of these three gene families were conducted in both *Arabidopsis* and cyanobacteria. An evolutionary model has been developed as a result of these analyses. Our results suggest that the three gene families appear to have evolved in parallel from a common ancestor in both *Arabidopsis* and cyanobacteria, via tandem duplication and divergence, domain deletion, and domain fusion. Each family appears to have a common proximate ancestor in *Arabidopsis*, as well as in the IDS and TPS (but not TTPS) of cyanobacteria. Cyanobacteria TTPS have likely evolved from two different but related proximate ancestors. *Arabidopsis* and cyanobacteria GGPPS exhibit higher homology to each other than to the other IDS in the same species as the most conserved group among the three families. Most other subfamilies exhibit species-specific homology to each other. Our results on *Arabidopsis*, cyanobacteria and moss provide novel insight into the evolution, relatedness and function of short-chain IDS, TPS and TTPS.

BIOLOGY

3. Regulation of Neural Crest Cell Emigration in Turtle (*Trachemys scripta*) Embryos.

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The plastron is the portion of the turtle shell that covers the turtle's belly. The developmental origin of the turtle plastron continues to be controversial. The plastron bones appear to be formed from a specialized cell type known as trunk neural crest, which has not previously been shown to form bone. Neural crest precursor cells stay at the neural plate border during neurulation and then come to reside in the dorsal neural tube. The precursors then detach and migrate throughout the body. The premigratory neural crest precursor population expresses a characteristic set of transcription factors, which includes Snail2, FoxD3, Sox9, and Sox10, that regulates cell differentiation and migration.

The period of time over which trunk neural crest cells emigrate from the neural tube appears to be much longer in turtle embryos than in other amniote embryos. There appears to be a second, late emigrating group of trunk neural crest cells in turtle embryos that are not found in chicks or mice. This second group appears to be skeletogenic and responsible for the formation of the bones of the plastron. It is not known whether the region of premigratory cells in the dorsal neural tube persists in a dormant phase during the period when neural crest cells are not emigrating, or whether the ability to generate neural crest cells is re-induced in the older turtle embryos. To address this question, we investigated the expression of premigratory neural crest markers in the neural tube of turtle embryos at different stages of development. If the expression of these genes persists throughout all stages, this will suggest that the premigratory region is maintained, and that the lack of neural crest cell migration could be due to the lack of a supportive environment. In contrast, if they are only expressed during the periods of neural crest cell migration, then the second wave of neural crest cell migration would require a second inductive signal not found in chick embryos.

4. Automated Detection and Identification of Winter Bird Vocalizations.

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Automated recording devices and automated identification software are technologies widely available to researchers attempting to survey sites for diversity of vocal fauna. During this study, we evaluated the efficiency of a fully automated process for bird identification based on target vocalizations of four Pennsylvania winter bird species. A Wildlife Acoustics SM-2 automated call recorder was placed along a forest edge near Millersville, PA. Call recordings were then screened by Wildlife Acoustic's Song Scope call recognition software after evaluation by trained personnel. We found that Song Scope software performed differently based on the species target vocalization. The software performed at 79.37 % accuracy for the basic song of the Carolina Wren (*T. ludovicianus*), 73.58% for the "jay" call of the Blue Jay, (*C. cristata*), 22.55% for the call of the Carolina Chickadee (*P. carolinensis*) and at 9.09% for the clear whistled song of the White-throated Sparrow (*Z. albicollis*). The program screened ten hours of personnel previewed field recordings in an average of seven minutes. Obtaining calls and creating a "recognizer" model (the model that screens the field recordings for a vocalization match) in Song Scope took, on average, more than five hours per species. However, a database of 'recognizer' models would

BIOLOGY

make automated surveying a more efficient way to test for diversity of certain vocal species. The creation of such a database would need to be a multi-regional collaborative effort and include many hours of recordings to develop robust 'recognizer models' using standard software parameters that could be agreed upon.

CHEMISTRY

5. Methods of Size Determination of CdSe/ZnS Quantum Dots and Attachment of Hydrophilic Thiol Ligands that Impose Biocompatibility.

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The objective of this research project is to produce a biologically compatible nanomaterial that produces an intense emission spectrum for biosensing and imaging. To achieve this objective, Cadmium Selenide (CdSe) quantum dots were coated with a Zinc Sulfide (ZnS) shell and various ligands were attached to the subsequent core-shell system. Spectral analysis of the CdSe quantum dot system can reveal a plethora of information. Computational determination was attempted of the diameter of a CdSe quantum dot from its spectral data by use of quantum mechanics and the particle-in-a-box theory. Quantum dots have the potential to produce high-resolution cellular imaging on the single-molecular level. Much care is taken to preserve and analyze the photo-properties of the synthesized quantum dots. This research project focuses on the spectral properties of CdSe/ZnS quantum dots as they are attached with organic and inorganic ligands. By studying these nanoparticles and their properties, we can grasp the mechanics that occur on the nano-scale as well as help find solutions for the problems we face in our modern society.

EARTH SCIENCES

6. The Spatial Distribution of Phytoplankton Groups in the Western North Atlantic Ocean Using High Performance Liquid Chromatography (HPLC) Pigment Analysis.

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Phytoplankton are important primary producers in many marine ecosystems, and it is important to understand their taxonomic diversity within and between the ocean's major biomes. One approach is to view phytoplankton as belonging to functional groups based on cell size, an important parameter controlling the characteristics of microbial ecosystems. Another approach is to classify phytoplankton according to taxonomic groupings based on genetic relatedness. We used HPLC pigment data to estimate the diversity of phytoplankton size and taxonomic groups, along an ocean transect extending from the continental shelf sea south of New England, to the western Sargasso Sea near Bermuda, during the spring and summer seasons. When the data were grouped according to size classes, Fnano tended to be the most common group. However, fpico was found in significant amounts in every environment and fmicro, though usually the rarest group, was found to outclass the other two groups in locations with low amounts of sunlight but high amounts of nutrients, such as the lower depths of the ocean's euphotic zone. Data on phytoplankton distributions based on genetic relatedness using the computer algorithm CHEMTAX, is in the preliminary stages of analysis and will also be presented and compared to the size group analysis.

NURSING

7. Instituting Midlevel Provider Utilization in Emergency Department Triage and Patient Throughput Outcomes.

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In current health care literature, considerable research addresses worldwide emergency department overcrowding by focusing on “Front-end” operations. These carefully examined approaches have the ability to improve patient throughput efforts thus decreasing the length of stay (door to exit time) in the emergency department and decreasing the number of patients leaving without treatment (LWOT). Other results from streamlining front-end procedures demonstrate improved quality, cost, patient satisfaction and a decrease in delay of treatment. There are many front-end operations that can be utilized. This research specifically examined the implementation and subsequent effect of placing a midlevel physician extender (Nurse Practitioner or Physician Assistant) in triage or “provider in triage” (PIT). A retrospective data review of the initiation process of PIT in an urban Pennsylvania emergency department (Pinnacle Health System Harrisburg Hospital) was conducted. Data review from before the implementation (January 1-April 14, 2013) and post implementation period 1 (April 15-June 30, 2013) and post period 2 (July 1, 2013-December 31, 2013) was completed after obtaining Institutional Review Board approval from Pinnacle Health System and Millersville University.

A chi-square was used to compare LWOT rate and a student t-test was applied to compare length of stay. Results demonstrated that the length of stay was reduced by 8.6 and 6.42 minutes respectively, in patients evaluated in triage by a PIT provider. LWOT rates were reduced from 2.22% to 1.76% within eight months demonstrating a significant reduction ($p < 0.0001$) and was statistically significant. Door to provider evaluation time was reduced by 10.5 minutes for discharged patients. The intervention was successful. Implications for further research and for nursing are examined such as evaluating patient satisfaction. A reduction in LOS, LWOTs and delay in treatment or evaluation after a midlevel provider implementation in triage can assist in decreasing overcrowding by increasing patient throughput in the emergency department.

PHYSICS

8. The Energy flow of Linear and Circular Dipoles in a Dielectric Medium.

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The energy flow lines of radiation emitted by a linear dipole in free space are radially straight. This is observed by analyzing the field lines of the Poynting vector. When a linear dipole is placed in an energy absorbing medium, such as water, the field lines begin to exhibit a partial curvature. Our research shows that due to the damping in a dielectric medium, the direction of the energy flow lines are altered in the near field. However, the curved field lines in the near field do not contribute to energy flow in the far field. For a circular dipole in a dielectric medium the field lines possess a vortex feature in the near field, and then the field lines become radially straight approaching the far field.

9. Columnar Thin Films as Gas Sensors.

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Sculptured thin films are nanostructured materials with unidirectionally varying properties that can be designed by controlling physical vapor deposition variants. Columnar thin films (CTF), a subset of Sculptured thin films, are comprised of parallel nanocolumns with void space throughout the film. CTFs are fabricated by glancing angle or oblique angle deposition in a vacuum chamber with controlled substrate temperatures and fixed angle of incidence. Due to the porous nature of CTFs, gaseous species can diffuse throughout the film, causing changes to its electromagnetic properties such as its relative permittivity. A process which is sensitive to changes in relative permittivity is Surface Plasmon Resonance (SPR). SPR is the oscillation of valence electrons at the interface between two materials where the real part of the dielectric function changes sign across the interface. When a surface plasmon is excited, a drop in reflection intensity is observed in the experimental setup. Porous gold films of 170 nm thickness were fabricated and SPR was performed in various moisture content environments.

10. X-Ray Analysis of SNRs DEM L316a and N206 in the Large Magellanic Cloud.

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We present an X-ray study of supernova remnants (SNRs) DEM L316a and N206, both located within the Large Magellanic Cloud. There are two different explosive mechanisms that cause supernovae; the thermonuclear detonation of a white dwarf star that has exceeded the Chandrasekhar Mass Limit (Type Ia) and the gravitational core collapse of a massive star (Type II, Ib/c). All elements heavier than iron are created in these detonations. The remnants of these explosions go through three evolutionary phases, the expansion phase, the Sedov phase, and the radiative phase. We can learn about the progenitors of these SNRs through an analysis of their X-ray spectra. Spectral data for these two targets was gathered from the Chandra X-Ray space telescope and stored in NASA's High Energy Astrophysics Science Archive Research Center (HEASARC). The CIAO software package was used to examine the data from HEASARC, and the XSPEC package was implemented to fit the data to the Sedov, Non-Equilibrium Ionization,

PHYSICS

and the Parallel-Plane Shock models. The Sedov model can be used to determine the age, mass of the matter swept up by the shock wave, and the initial explosion energy. Chandra data has high spectral resolution as well as high spatial resolution. This lets us perform spatially-resolved spectroscopy on various regions of the remnants. The Sedov model is fitted to the limbs, and that result is added to our model fits of the central region. This basically subtracts the contribution of the limbs from our analysis of the central regions. The Non-Equilibrium Ionization and the Parallel-Plane Shock models can then account for an excess emission in the central regions where we find the stellar ejecta created by the explosions. Our goal is to ascertain the elemental abundances of the supernovae ejecta to determine the type of explosion that created these remnants.

11. Optical Properties of Sculptured Thin Films.

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Thin films can be produced from a variety of methods the most common is physical vapor deposition. Thin films can exhibit column like structures that can be altered during deposition by using oblique angle and glancing angle techniques. By changing the angle of the incident flux on the substrate sculptured thin films can be fabricated that exhibit different shapes such as zigzags or chevrons. Columns are formed from the effects of shadowing that occur during deposition and dictate how columns will grow. To produce defined columns shadowing effects must be enhanced and surface diffusion minimized. This is done by depositing at low pressures and maintaining a substrate temperature that is lower than the melting point of the material. Due to anisotropic nature, sculptured thin films exhibit a variety of optical properties. A sculptured thin film of a certain material can exhibit different transmission spectra than a bulk film of the same material. To investigate this property, columnar thin films of silver, copper and gold will be fabricated and their transmission spectra analyzed to determine the relationship between structure and transmission. By using substrate rotation columnar structures with helical morphology may also be fabricated. Several depositions were performed to determine the deposition parameters required to fabricate thin films with columnar structures. Once sculptured thin films can be fabricated with the current system then their optical properties can be studied.

12. Dark Matter in Galaxy Cluster A2029.

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In this project the mass of dark matter in galaxy cluster Abell 2029 is determined by analyzing X-ray data collected by the *Chandra* X-ray Observatory. The material in the inter-cluster medium (ICM) covers most of the cluster, is more massive than the total mass of all the galaxies in the cluster, and is a strong source of X-ray emission. Spectra is extracted from the observation and fit to an equilibrium ionization model to find the plasma temperature and emission measure. Plasma temperature is related to kinetic energy which can be applied to the virial theorem. The virial theorem relates to gravitational potential energy to kinetic energy and lets us calculate the virial mass of the cluster. That is the mass required to account for the observed kinetic energy within the cluster. The mass of X-ray emitting gas is then found to compare to the virial mass.

PHYSICS

The data is separated into concentric regions and analyzed with the same equilibrium ionization models. The emission measure is related to the normalization parameter of the model. From that we can determine the ion density of the ICM which allows the calculation of the mass of the X-ray emitting gas. The difference between the virial mass and the total X-ray mass will provide a measure of the mass of dark matter in the cluster.

13. An Experimental and Theoretical Study on the Interaction of Soap Bubbles on a Fluid Interface.

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The surface tension of water and soapy water were measured two different ways and the results were then compared. The first method excited capillary waves and measured the relationship between the frequency and wavelength by monitoring the distortion of the surface by means of a laser beam. The second way, determined the surface tension by using the Wilhelmy's plate method. The contact angle was measured by taking a digital photograph of a droplet and using Logger Pro. A floating particle at rest on the surface of a liquid will interact with another floating particle at rest nearby because of the deformation both particles cause on the surface of the liquid. The contact angle and the density of the sphere will cause the surface to deform. The physical condition of two spheres attracting one another was derived. The equation for the force and energy of interaction for a simple model was derived as well. These derivations were then compared with experimental results. The contact angle for the microscope slide and water was 37.2° . The contact angle for soapy water was 17.5° . Using the diffraction grating method the surface tension for distilled water was (0.0724 ± 0.004) N/m and for soapy water the result was (0.031 ± 0.008) N/m. The surface tension for the water using the Wilhelmy's plate was measured (0.0725 ± 0.0006) N/m and the surface tension of soapy water is (0.0378 ± 0.0002) N/m.

INDEX

<u>Name</u>	<u>Abstract Number</u>
Cebra-Thomas, Judith *	3
Conrad, Tristan	1
Dushkina, Natalia *	9, 13
Fowler, Matthew	6
Gilani, Tariq *	9, 11
Gochnauer, Heather	3
Grffin, Meta	1
Haines, Aaron *	1,4
Hendrick, Sean P. *	10, 12
Hinerman, George	8
Kennedy, Steven*	1
Kettering, Jonny	2
Kuhns, Kelly A. *	7
Li, Xin *	8
Long, Daniel	9
Luckenbill, Brian	10
McClintock, Katherine	11
MeKeel, Paige E.	12
Miller, Kevin	10
Minter, Cayleigh	7
Mylin, James M.	13
Nguyen, Lisa	5

INDEX

Parker, Michael	.....	2
Schiza, Maria V.*	.....	5
Smith, Matt	.....	3
Vaillancourt, R. D.*	.....	6
Wolfgang, Andrew	.....	4
Zhong, Yuan*	.....	2

An asterisk (*) denotes the SCMA Faculty Advisor for the student research