Abstracts

Regional Undergraduate Poster Competition

Jacobs Science Building
April 17, 2026
11:30am-4:00pm

University of Kentucky
Department of Chemistry
Lexington, KY 40508

Group A		**Group B**	
1	Mahmood Ateyeh University of Kentucky	**2**	Izzy Rivera University of Kentucky
3	Sydney Cobb University of Kentucky	**4**	Callista Huber University of Kentucky
5	Aden Runyon University of Kentucky	**6**	Lee Dix University of Kentucky
7	Rianna Mueller University of Kentucky	**8**	Peyton McCubbin University of Kentucky
9	Daniel Raygoza University of Kentucky	**10**	Walter Kunnman University of Kentucky
11	Natasha Schalk University of Kentucky	**12**	McKenzie Wirtz University of Kentucky
13	Cami Sergent University of Kentucky	**14**	Nathan Bearden University of Kentucky
15	Nikhil Kumar University of Kentucky	**16**	Isabella Soon University of Kentucky
17	Carlee O’Neal University of Kentucky	**18**	Ian Phares University of Kentucky
19	Matthew Corbett University of Kentucky	**20**	

***Group A presents from 12:00-1:30 PM**
***Group B presents from 1:30-3:00 PM**

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Characterizing Alzheimer's Disease-Associated Lipid Droplet Burden

Mahmood Ateyeh, Junior, Chemistry, University of Kentucky

Omar Hamid, Agricultural and Medical Biotechnology, University of Kentucky
Lance Johnson, Neuroscience, University of Kentucky

Abstract

Alzheimer’s disease is the most common form of dementia, characterized by amyloid beta plaques and neurofibrillary tangles, but also by the presence of understudied “adipose saccules” in glial cells such as microglia and astrocytes. Adipose saccules likely represent lipid droplets, which are bona fide organelles that serve roles in mediating lipotoxicity, autophagy, and membrane homeostasis. A protein known as apolipoprotein E (APOE) is a lipid droplet-associated protein. Previous and current studies have focused on amyloid beta plaques and tau tangle accumulation in Alzheimer’s pathogenesis, while this study integrates genetic and environmental factors linking lipid droplet dysbiosis to Alzheimer’s pathology. The goal of this experiment is to image the distribution of lipid droplets across the brain in glial cells based on factors including the mouse’s genotype (either homozygous for the E2, E3, or E4 isoforms of APOE), sex (male or female), age (young or old), diet (Western diet or chow diet), and amyloidosis model (heterozygous 5xFAD mice or wild type). Mouse brains were cryosectioned into 30-micron coronal sections and then processed for immunohistochemistry staining for microglia (IBA1), astrocytes (GFAP), lipid droplets (Plin2), and amyloid beta plaques (Amylo-Glo). Mouse brains were imaged with the Nikon AXR confocal microscope, and HALO software was used for regional annotation and analysis. The initial results of this study showed a consistent upward trend in Plin2-positive and Plin2-IBA1-positive colocalization in E2/E2, E3/E3, and E4/E4 mice. The lipid-droplet burden is expected to be higher in female mice or aged mice compared to male mice or younger mice; in addition, mice on a Western diet or with the 5xFAD mutation are expected to be more lipid-burdened than mice on a chow diet or wild-type mice. The results of this study will be used to generate a lipid droplet atlas as a free community-wide res ource.

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Synthesis and Purification of Machilin D Derivatives for Application in Triple Negative Breast Cancer Therapeutics

Izzy Rivera, Senior, Chemistry, University of Kentucky

Samuel Awuah, Chemistry, University of Kentucky
Alyson Olivelli, Chemistry, University of Kentucky

Abstract

Lignans are naturally occurring polyphenols that are used for defense against stressors in plants. Machilin D is a lignan found in certain plants native to East Asia that have a history of application in traditional Chinese Medicine. Literature points to Machilin D's cytotoxic properties in Triple Negative Breast Cancer cell lines by underexpressing certain transcription factors and decreasing concentration of cytokines responsible for tumor growth. The issue with this, however, is that Machilin D's yield in plants is minimal and infeasible for direct application to cancer therapeutics. However, chemical synthesis of Machilin D is fast, cheap, and yields much more product than natural occurrence. Derivatives of Machilin D were synthesized to exploit the inherent cytotoxicity of the lignan while also introducing some structural and heteroatomic modification to improve the bioactivity and lead to a better therapeutic for Triple Negative Breast Cancer. A library of these compounds have been synthesized, purified, and tested in vitro. One of the derivatives has been tested in-vitro and determined to have greater cytotoxicity than Machilin D, confirming that continued s tudies of derivatives are worth-while. Expanding this library, fatty amine derivatives are the newest to be synthesized, purified, and tested in-vitro.

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Development of a Screening Approach for Rectovaginal Fistula Detection

Sydney Cobb, Senior, Chemistry, University of Kentucky

Marcelo Guzman, Chemistry, University of Kentucky

Abstract

Rectovaginal fistulas (RVFs) are abnormal connections between the rectum and vagina that are frequently underdiagnosed due to patient discomfort, limited access to specialized care, and the invasive nature of existing diagnostic methods. This project focuses on the development of a screening device designed for use in home settings to support earlier identification of RVFs. The proposed approach explores a materials-based strategy for generating a visible response correlated with conditions associated with fistula leakage. This design emphasizes ease of use, rapid visual interpretation, and the absence of specialized instrumentation. Prototype devices were fabricated using rapid-prototyping techniques to evaluate feasibility and user interaction considerations. By prioritizing simplicity and accessibility, this screening strategy has the potential to improve detection of RVFs, particularly in medically underserved populations, and to reduce barriers associate d with current diagnostic practices.

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Development and Optimization of Mucoadhesive Nicotine Patches to Mimic Oral Nicotine Pouches

Callista Huber, Senior, Chemistry, University of Kentucky

Claire Ray, Chemistry, University of Kentucky
Chris Richards, Chemistry, University of Kentucky

Abstract

Oral nicotine pouches (ONPs) are an increasingly popular smokeless nicotine delivery product, particularly among adolescents and young adults. Since their introduction, products such as Zyn have rapidly gained market dominance. Despite their widespread use, there is limited research on the health and neurological effects of ONPs, largely due to the absence of a physiologically relevant animal model. This gap restricts our ability to evaluate how sustained buccal nicotine exposure influences addiction and overall health. To address this need, we aim to develop a murine model that mimics ONP exposure using mucoadhesive buccal nicotine patches (MNPs). These patches are designed to replicate the buccal absorption delivery and kinetics of ONP use in humans. Direct use of ONPs in mice is not feasible due to the keratinized buccal epithelium present in murine tissue, which differs from human buccal mucosa. Therefore, MNPs are used to overcome the keratinized epithelium, enable controlled adhesion, and nicotine delivery kinetics. MNPs are created via a solvent casting method, followed by inkjet printing of nicotine onto the patch surface to allow precise control over dosing and distribution. This project focuses on optimizing the formulation of MNPs to ensure effective adhesion, consistent nicotine delivery, and biocompatibility. Preliminary testing is conducted to evaluate peel-ability, flexibility, swelling behavior, mucoadhesion time and strength, and nicotine diffusion across synthetic and porcine buccal membranes. Based on the results of our optimization, two MNP formulations have been developed for use in the proposed in vivo murine model. Based on these optimization studies, two MNP formulations have been identified for use in an in vivo murine model. By developing the first physiologically relevant model of ONP exposure, this project will provide a valuable platform for studying how sustained buccal nicotine delivery affects neurology and human health.

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Understanding Cyclic Voltammetry: A Look into the Black Box of Instrumentation

Aden Runyon, Senior, Chemistry, University of Kentucky

Arthur Cammers, Chemistry, University of Kentucky

Abstract

Instruments can be mysterious in how they acquire and processes data. If the user had no part in building the hardware or software, the data can be misinterpreted. Chemical education gives undergraduates specific procedures on how to use and interpret data from specific instruments but on some level the instrument is a black box, lacking internal detail that could affect how the data could be more accurately interpreted. Since electronics are readily available in the advancing world of the maker movement, perhaps this approach can be used to address this black box problem. Cyclic voltammetry is a fundamental electrochemical method to understand the reduction and oxidation (RedOx) properties of a solution-state molecules. This project borrows from the maker movement by understanding the internal components of a potentiostat to perform cyclic voltammetry by constructing one. We go into the depth of the optimization required for the instrumentation to give a precise output. Additionally, we went into detail of what is required to apply this instrumentation to a microcontroller. The details explored included amplifying voltages and managing detection error to allow Arduino to deliver and pick up a quiet voltage input and current output. This allowed us to learn more about intricate details of application of electronics to instrumentation. The goal of this project is to allow undergraduate students to understand the circuitry behind cyclic voltammetry with the hopes of applying it to undergraduate educational settings. By using accessible parts, this project can be translated into a classroom setting where undergraduates with a background in elementary Electro-Magnetism, general/analytical chemistry, and basic electronics can understand the black box of cyclic voltammetry.

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Glycosaminoglycan-interacting small molecule treatment lowers TDP-43 expression in G348C mouse model

Lee Dix, Junior, Chemistry, University of Kentucky

Maj-Linda, Molecular and Cellular Biochemistry, Sanders-Brown Center on Aging
Valerie Allen, Neuroscience, University of Kentucky

Abstract

TDP-43 is a DNA- and RNA-binding protein encoded by the TARDBP gene whose cytoplasmic aggregation is associated with neurodegenerative diseases such as ALS and FTD. TDP-43 pathology is believed to spread through prion-like seeding mechanisms, and may be mediated by glycosaminoglycans (GAGs) in the extracellular matrix. Glycosaminoglycan-interacting small molecules (GISMOS) may interfere with this process and reduce TDP-43 propagation. This study aims to determine the effect of the GISMO compound GTC-3295 on TDP-43 expression in a G348C ALS/FTD mouse model. WT and G348C mice were treated with varying doses of GTC-3295 between 7 and 10 months of age. Brain tissue was analyzed using immunohistochemistry to assess TDP-43 expression across cortical and hippocampal regions. GTC-3295 treatment reduced TDP-43 expression in G348C mice, with the 10 mg/kg dose producing the most significant decrease across all regions, particularly in the hippocampus. Higher dosing (especially 30 mg/kg) resulted in a less significant effect, suggesting a more complex response than anticipated. Treated mice at the moderate dose showed TDP-43 levels most comparable to wild-type controls. These results support the role of GAGs in TDP-43 propagation and identify GTC-3295 as a potential therapeutic candidate for TDP-43 proteinopathies. The reduced effect at higher doses indicates the need for further investigation regarding mechanisms for GAG involvement with TDP-43 seeding.

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Design of deep eutectic solvents (DESs) for the selective recovery of critical metal ions from mine waste

Rianna Mueller, Senior, Biosystems Engineering, University of Kentucky

Jian Shi, Biosystems Engineering, University of Kentucky

Abstract

Developing sustainable methods for critical metal recovery is essential for addressing global supply chain shortages while reducing the environmental impact of conventional mining. Hydrophobic type-V deep eutectic solvents (DESs) represent a promising low-toxicity alternative because they can be formulated from small molecules selected from a broad chemical space. The objective of this project was to formulate and evaluate DES systems based on naturally derived ligands for the selective extraction of critical metal ions. Hydrophobic DESs were prepared from binary mixtures of 2,6-dimethoxyphenol, lidocaine, decanoic acid, menthol, and thymol. The DESs were synthesized by heating solid components at 70 °C for 2 h at various molar ratios. Solvent extraction experiments were carried out by contacting equal volumes of the hydrophobic DES phase and aqueous metal ion solutions containing K+, Co2+, Ni2+, Mn2+, Ce3+, Dy3+, Nd3+, and Y3+. Metal ion concentrations in the a queous phase before and after extraction were quantified by ICP-OES. DESs containing lidocaine exhibited selective extraction of rare earth elements (REEs) over other metal ions. In addition, selectivity among REEs could be tuned by varying the DES counter component (the hydrogen-bond donor), as well as the molar ratio. These results demonstrate promising hydrophobic DES solvent systems for the selective recovery of critical metal ions.

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Analyzing the Diffusion Mechanism of Ternary Manganese Oxide Nanowires

Peyton McCubbin, Senior, Chemistry, University of Kentucky

Lateefat Jimoh,Chemistry, University of Kentucky
Beth Guiton,Chemistry, University of Kentucky

Abstract

Ternary metal-oxide nanowires have emerged as a viable material for the advancement of energy storage systems. In particular, manganese-containing ternary metal oxides have been shown to have especially favorable qualities for efficient and reliable energy store. Previous data collected ex-situ suggests that the solid-state synthesis of these nanowires from manganese oxide (MnO2) and a metal hydroxide results preserved nanowire morphology throughout this reaction. This project shows the solid-state synthesis and characterization of lithium manganese oxide (LiMn2O4) nanowires ex-situ, due to the promising performance of these materials as lithium-ion battery cathodes. To determine the phase evolution of these materials, an in-situ transmission electron microscopy (TEM) approach was utilized. Synthesis of these materials required two distinct reactions: the hydrothermal synthesis of MnO2 nanowires, and the solid-state synthesis of LiMn2O4 from MnO2 and lithium hydroxide (LiOH). Synthesized nanowires were then characterized to examine composition, purity, and morphology using X-ray diffraction and scanning electron microscopy (SEM). Results showed LiMn2O4 nanowires of optimal morphology, comparable to that of MnO2, despite a change in composition reflecting the desired product. Energy dispersive spectroscopy (EDS) showed the intercalation of manganese out of the MnO2 nanowires to react with surrounding LiOH, resulting in a wire of changed composition, but unchanged morphology. Selected area electron diffraction (SAED) patterns also confirmed this change in phase as temperature increased in the reaction and determined at what temperature this process was occurring. These conclusions allow for the more effective use of LiMn2O4 in energy storage materials, as they provide insight into the mechanism by which these changes are occurring. This study has continued to expand on the diffusion mechanism of Mn-containing metal oxides, as current work is being extended in copper manganese oxide (CuMn2O4).

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Diamine Cation Perovskites and Their Influence on Piezoelectricity

Daniel Raygoze, Senior, Chemistry, University of Kentucky

Aaron Huckaba, Chemistry, University of Kentucky
Youselie Joseph, Chemistry, University of Kentucky

Abstract

Perovskites are semiconductor crystals that have attracted growing interest due to their unique optical and electronic properties. When light is absorbed, electrons are excited, and electron-hole pairs are generated within the crystal structure. In this study, hybrid perovskites were synthesized using lead halide frameworks and diammonium spacer cations of varying size and chirality. The spacer cations used include (R)- and (S)-1-phenylethane-1,2-diaminium, ethane-1,2-diaminium, (R)- and (S)-propane-1,2-diaminium, and (S)-Piperidin-3-amine dihydrochloride.

By varying the size and chirality of the organic spacer, this study aims to observe how molecular structure influences the optical and electronic properties of the resulting crystals. Understanding how the structure of the diammonium spacer tunes the properties of these hybrid perovskites may contribute to the broader study of organic-inorganic hybrid crystalline materials.

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Mutational analysis of a monomeric bifurcating electron transfer flavoprotein

Walter Kunnmann, Senior, Chemistry, University of Kentucky

Anurag Priyadarshi, Chemistry, University of Kentucky
Anne-Frances Miller, Chemistry, University of Kentucky

Abstract

Electron transfer flavoproteins (ETFs) are found in all domains of life, and they carry out various functions. In eukaryotes, they mainly function as an electron transport step to mediate fatty acid oxidation and respiration; however, ETFs in many microorganisms catalyze electron bifurcation, a biological energy conservation mechanism that couples favorable and unfavorable electron transfer reactions within a single catalytic cycle. In bifurcating ETFs, a pair of electrons derived from a donor such as NADH is split such that one electron is transferred to a high potential acceptor while the second is driven toward a low potential acceptor. This process enables the formation of products with more reducing power than the original donor, and allows these organisms to drive energy demanding biochemical pathways such as nitrogen fixation. The electron transfer flavoprotein from Sulfolobus acidocaldarius (SaETF) provides a useful system for studying bifurcation due to its monomeric structure, which includes a linker region connecting domains that are typically separated in heterodimeric ETFs. Bifurcating ETFs adopt 'open' and 'closed' conformations in solution, as the domains rotate around each other. Understanding how structural changes influence electron bifurcation is critical to further mechanistic insight of this energy conservation method. In this study, the linker region of SaETF was mutated to probe its role in conformational control. Mutations were selected based on sequence conservation, predicted structural effects, and expression into the soluble phase. Y261E was designed to introduce potential electrostatic interactions with nearby residues, and Δ279-280 was hypothesized to shorten the linker and restrict domain motion. Mutant structures were modeled and analyzed through free-energy calculations to assess stability. Purified mutant proteins' molecular weights were assessed through SDS-PAGE, their flavin stoichiometry throu gh absorbance spectroscopy, and dynamic light scattering was used to evaluate changes in hydrodynamic radius. DLS analysis of mutant Y261E showed extended conformations in solution.

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Using Multimedia Principles to Improve Memory Recall of Periodic Table Elements with Nonintuitive Chemical Symbols

Natasha Schalk, Senior, Chemistry, University of Kentucky

Stephen Testa, Chemistry, University of Kentucky

Abstract

The Periodic Table is one of the most important tools in chemistry, yet many students struggle to memorize element symbols that do not match the element's English name. Many of these mismatches come from Latin or historical names. The purpose of this study was to develop visual learning tools, in the form of illustrations, to help students remember elements with nonintuitive symbols. To create these tools, a list of elements with non-matching symbols was compiled, and each element was paired with an illustration representing both the element's name and symbol. These images were designed to interact visually and strengthen the connections between the two. The final product was a set of 11 multimedia-style flashcards that include illustrations, labeled connections between the illustrations and the element name or symbol, and a traditional Periodic Table box for reference. Pilot testing was not conducted due to time constraints, but future research could evaluat e how effective these tools are in improving student recall.

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Synthesizing sustainable Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) via upcycling bourbon stillage

McKenzie Wirtz, Senior, Chemistry, University of Kentucky

Gosia Chwatko, Chemistry, University of Kentucky
Jason Stallings, Chemical Engineering, University of Kentucky

Abstract

Current plastics are often non-degradable, which leads to a buildup of plastic waste in the environment and in our landfills. While some plastics need to be very resilient to match the requirements of the application, single-use plastics do not need the same levels of resistance. Polyhydroxyalkanoates (PHAs) are a class of polymers proposed to replace the currently used plastics in this application. PHAs are synthesized using microorganisms and thus require plenty of sugars to keep the microorganisms alive and producing PHA. This comes at a high cost driving the overall cost of PHA production above the pertrochemical counterparts. In this project, we aimed to use a local waste product from bourbon production (stillage) and convert it to a processable substrate for Haloferax mediterranei, a PHA producing microbe. The goal of my work was to study the impact of stressors on the properties and performance of this microorganism.

The growth of H. mediterranei was obtained using a UV-Vis. plate reader at 520nm that detects the pink carotenoid production associated with cell growth over the course of six days. NMR samples were used to check the quality and type of PHA produced. Stressor tests involve increased glucose levels, adding Li, adding Bleach (0.1%), and increased oxygen during inoculation. These tests showed an increase rate of cell growth, specifically with oxygenation results displaying an exponential growth rate. The results show that if there is an increased bacterial growth in these conditions, PHBV production is not always correlated. Using these relationships between favorable/unfavorable environments and growth rates, translation to bourbon stillage enzyme treatments is currently being processed. Moving forward, specific enzyme treatments for stillage are applied to create a habitable environment for the microorganism to grow and produce high yields of PHBV.

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Single Molecule Dissection of DNA G-Quadruplex and Alpha-Synuclein Interactions

Cami Sergent, Junior, Chemistry, University of Kentucky

Dr. Prakash Shrestha, Chemistry, University of Kentucky
Hasanul Kabir Rafi, Chemical Engineering, University of Kentucky

Abstract

Alpha-Synuclein (**α**-Synuclein) is an intrinsically disordered protein that aggregates into amyloid fibrils associated with neurodegenerative diseases such as Parkinson's Disease. Recent studies have suggested that nucleic acid G-quadruplex (GQ)structures, commonly found in promoter and telomere regions of the human genome, may regulate **α**-Synuclein aggregation, however, the underlying mechanisms remain unclear. Here, we use single-molecule optical tweezers assay to directly probe interactions between the GQ DNA and **α**-Synuclein at the single molecule level. We find that **α**-Synuclein significantly stabilizes GQ structures, as evidenced by increased unfolding forces, indicating modulation of the GQ energy landscape. This stabilization likely arises from a combination of electrostatic interaction to the negatively charge GQ backbone, multivalent interactions enabled by intrinsically disordered nature of **α** -synuclein, and π–π stacking interactions with G-tetrads. These results highlight a mechanistic link between GQ structure and protein aggregation, suggesting potential implications for **α** -synuclein-mediated modulation of gene regulation and GQ-scaffold-mediated nucleation of early aggregation pathways.

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Flash Nanoprecipitation for Encapsulation of EtTP-5 Dye in Polymeric Nanocarriers

Nathan Bearden, Senior, Chemistry, University of Kentucky

Christopher Richards, Chemistry, University of Kentucky
Sagar Pande, Chemical Engineering, University of Kentucky

Abstract

Flash nanoprecipitation (FNP) is a method of turbulent mixing used to encapsulate hydrophobic core materials within a hydrophilic shell. This technique is used to facilitate the assembly of block copolymer nanocarriers for the transport of water-insoluble substances. Here, we explore the use of FNP to encapsulate a hydrophobic EtTP-5 fluorophore within an amphiphilic carboxylic acid-poly(ethylene glycol)-b-poly(lactide-co-glycolide) (PLGA-b-PEG-COOH) nanocarrier. We prepared solutions with dye masses ranging from 0.5% to 10% of the polymer mass. The synthesized nanoparticles were characterized by a nanoparticle tracking analyzer (NTA) and a fluorescence spectrometer. The ensemble average fluorescence was normalized using the concentration of the particle solutions to obtain the average fluorescence per particle. By comparing the fluorescence of particles synthesized using different masses of dye, we were able to determine an optimal dye-to-polymer mass ratio to achieve enhanced fluorescence and minimized aggregation-caused quenching (ACQ). While the highest ensemble average fluorescence was observed when a dye mass of 2% was used, we found that a mass of 0.5% relative to the polymer mass resulted in the highest single-particle fluorescence, while the other solutions appeared to be more prone to aggregation-caused quenching.

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Development of a Novel Point-Of-Care Differential Scanning Calorimeter for Diagnosis of Cancer

Nikhil Kumar, Sophomore, Chemistry, University of Kentucky

Nichola Garbett, Medical Oncology and Hematology, Department of Medicine, University of Louisville
Alagammai Kaliappan, Medical Oncology and Hematology, Department of Medicine, University of Louisville
Gabriela Schneider, Medical Oncology and Hematology, Department of Medicine, University of Louisville
Thomas Roussel, Bioengineering, University of Louisville

Abstract

Early-stage cancer detection remains constrained by the limitations of contemporary diagnostic modalities, which are often invasive, cost-prohibitive, and insufficiently sensitive to proteomic perturbations preceding clinical symptoms. Differential Scanning Calorimetry (DSC), however, has demonstrated that the thermal denaturation profiles of blood plasma encode robust signatures of disease state, reflecting global changes in protein composition, stability, and intermolecular interactions. Yet traditional DSC instruments are inherently incompatible with point-of-care deployment due to their scale, thermal inertia, and operational complexity. In this work, we present the foundational development of a miniature, sensor-driven micro-DSC platform engineered for clinical translation. Central to this effort is the reformulation of the DSC's thermal feedback architecture at the microscale, achieved through the fabrication and comparative evaluation of two custom sensor geometries: a radial "spiderweb" trace layout and a redesigned rectangular trace configuration. By systematically analyzing their resistance–temperature response curves under controlled thermal ramps, we establish that sensor stability, governed by material selection, heat distribution symmetry, and trace topology, is the critical determinant of accurate calorimetric measurement. The rectangular architecture exhibits a predictable monotonic response, resolving the nonlinearities and short-circuiting artifacts inherent to the spiderweb design, and thereby establishing a viable microscale foundation for reproducing diagnostic thermograms. These findings constitute a necessary first step toward the realization of a portable DSC capable of generating clinically meaningful thermal fingerprints directly from undiluted patient plasma. We conclude by discussing the implications of integrating machine-learning frameworks for automated thermogram classification, and the broader potential of micro-calorimetric proteome profiling as a diagnostic modality scalable to low-resource clinical environments.

DNA Nanoswitch-Enabled Multiplexed Detection of Target microRNAs for Equine Disease Diagnostics

Isabella Soon, Junior, Chemistry, University of Kentucky

Prakash Shrestha, Chemistry, University of Kentucky
Ramdeep Shrestha, Chemistry, University of Kentucky

Abstract

Equine Sarcoid Disease is among the most prevalent tumors in equids, yet current diagnostic approaches, such as skin biopsy, carry a risk of local tumor dissemination. Recent studies suggest that microRNA (miRNA) profiling offers a minimally invasive alternative for diagnosis. Moreover, multiplexed detection of biomarker panels can significantly improve diagnostic accuracy and enable earlier diagnosis compared to single biomarker approaches. However, conventional miRNA detection methods, such as reverse transcription quantitative PCR (RT-qPCR), are time consuming, costly, and challenging to multiplex. Here, we propose a simple, efficient, and low-cost platform for multiplexed microRNA detection using DNA nanoswitches. This method utilizes a DNA scaffold hybridized with short backbone oligonucleotides, where target binding induces a topological transition from a linear to a looped conformation. This structural change produces distinct, slower-migrating bands during gel electrophoresis, enabling direct readout of target presence. Additionally, we incorporate fluorescent dyes into DNA nanoswitches as an orthogonal detection strategy to further enhance multiplexing capacity. Using DNA targets as a model system, we optimize gel electrophoretic conditions to directly visualize looped signals resulting from target binding. Next, we will apply this platform to detect multiple miRNA targets associated with Equine Sarcoid Disease and fully characterize its sensitivity, specificity, and multiplexing capability. This platform provides a scalable and accessible strategy for multiplexed detect ion of miRNA and protein markers and holds a strong potential for minimally invasive, early diagnosis of equine diseases, including Equine Sarcoid Disease.

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Symphony of the Cell: Translating Protein Structure into Music through Data Sonification

Carlee O'Neal, Senior, Chemistry, University of Kentucky

Lauren Potts, Neuroscience, University of Kentucky
Michael Baker, Music Theory and Composition, University of Kentucky
Timothy Moyers, Music Theory and Composition, University of Kentucky
Luke Bradley, Neuroscience, University of Kentucky

Abstract

Science and art, often treated as separate domains, share a common foundation in pattern recognition, creativity, and communication to pursue meaning. Building on this shared foundation, we present The Symphony of the Cell, an innovative data sonification framework that converts primary protein amino acid sequences and mutations into musical compositions. In this system, each amino acid is assigned a harmonic note and rhythmic value derived from biochemical properties such as hydrophobicity, while mutations introduce sonic dissonance, generating perceptible shifts that correlate with structural and functional changes in the protein. This approach reimagines molecular biology concepts through sound, offering a novel mode of immersive data interpretation while emphasizing the creativity embedded in scientific discovery. Initial versions of the sonification synthesizer were shared with middle and high school classrooms as part of the START Program and SeeSTEM summer outreach camp. Evaluation data demonstrate that utilizing sonification not only improved student comprehension but also strengthened a sense of belonging in STEM by presenting complex concepts in a more approachable and engaging format. These findings illustrate how creative, interdisciplinary strategies can expand the ways science is taught, experienced, and understood, ultimately inspiring broader participation in STEM learning.

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Synthesis of Bismuth Ferrite-based Multiferroic Fluid Suspensions

Ian Phares, Senior, Chemistry, University of Kentucky

Hashini Navarathne, Chemistry, University of Kentucky
Beth Guiton, Chemistry, University of Kentucky

Abstract

Bismuth Ferrite ($BiFeO_3$) is a room-temperature multiferroic material exhibiting coupled ferroelectric and magnetic order, making it a promising candidate for next-generation functional materials. In this work, a modified hydrothermal synthesis based on literature methods has been developed to reproducibly synthesize phase-pure $BiFeO_3$ nanoparticles. Structural characterization by X-ray diffraction (XRD) confirms formation of the rhombohedral perovskite phase, while transmission and scanning electron microscopy reveals an unexpected bimodal size distribution. The synthesis yields two distinct products: a red nanoparticulate powder (diameter ~20 nm) and a black microscale powder (diameter ~10 μm). Despite identical phase identification by XRD, the two products exhibit different physical properties, with the nanoscale material displaying weak ferromagnetism at room temperature and the microscale material showing no response to a handheld magnet.

Ongoing efforts focus on dispersing each product into a range of carrier media, including water, mineral oil, oleic acid, and the nematic liquid crystal mixture E7. These suspensions will be used to investigate how particle size, surface chemistry, and host medium influence magnetoelectric coupling in fluid environments.

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Investigation of Novel MNK Inhibitors for Targeting Translational Dysregulation in Neurodevelopmental Disorders

Matthew Corbett, Senior, Chemistry, University of Kentucky

Mark Lovell, Chemistry, University of Kentucky

Abstract

Mitogen-activated protein kinase-interacting kinases (MNKs) regulate mRNA translation and have been implicated in neurodevelopmental disorders, including severe forms of autism spectrum disorder. Dysregulation of translational control can alter neuronal function, making MNK inhibition a potential therapeutic target. However, limitations such as poor solubility and restricted brain penetration reduce the effectiveness of existing inhibitors. This study evaluates novel MNK inhibitor candidates, including UK-5141 and UK-507, in comparison to the established inhibitor eFT-508. HCT116 cells were treated with varying concentrations of each compound, and cell viability was assessed using MTT assays at multiple time points to evaluate treatment effects. Treatment with UK-5141 resulted in changes in cell viability relative to control conditions, with trends varying across concentrations and exposure times. In select conditions, the novel compounds demonstrated activity comparable to eFT-508. Confocal imaging was also used to assess treatment-associated changes in cellular morphology and changes in phosphorylated eIF4E, a downstream target of MNKs. Additional studies were performed to further investigate pathway-level effects. Overall, these findings suggest that UK-5141 and related compounds exhibit biological activity consistent with MNK inhibition and warrant further investigation. Future work is needed to confirm their mechanism of action and evaluate their properties in neuronal models.