Stability Studies Of Riboflavin Binding Protein

Students: Desara Muska

Faculty Sponsors: Marilee Benore, Simona Marincean

Abstract

The significance of Riboflavin (vitamin B2) in human metabolism is critical for metabolic reactions and homeostasis. The research involved refining the purification process of the B2 transport protein Riboflavin Binding Proteins (RBP). Analyses, including gel electrophoresis, provided insights into the stability characteristics of RBP, such as its degradation products, and accurate molecular weight.

BCHM 2 (Benore

Aromatic and Medicinal Plants Course Extraction, Characterization, and Product Development of Essential Oils of Specific Aromatic Plants

Students: Travis Branscum, Daniel Broadwater, Brennon Egan, Aaron Engelhardt, Kayla Leonard, Desara Muska, Draic Mullin, Hawraa Najaf, Elizabeth Schmidt, Tommy Smith, Alex Zaborski

Faculty Sponsors: Marilee Ann Benore and Simona Marincean

Abstract

Aromatic and medicinal plants contain chemical components proven to be beneficial for health, and highly utilized in medical, food and industry applications. While used for centuries, the detailed biochemistry of aromatic and medicinal compounds is only now being determined: metabolic synthetic paths unveiled, impact on cellular, metabolic and neuronal paths determined, and potential for use (and abuse) the focus of research globally. The chemical components induce anti-inflammatory, anti-microbial, and physiological influence, as well as induce behavioral and sensory experience that are employed in medical and wellness therapies.

Aromatic and Medicinal Plants Course Extraction, Characterization, and Product Development of Essential Oils of Specific Aromatic Plants

Students: Travis Branscum, Daniel Broadwater, Brennon Egan, Brennon Egan, Aaron Engelhardt, Kayla Leonard, Draic Muska, Draic Mullin, Desara Muska, Hawraa Najaf, Elizabeth Schmidt, Tommy Smith, Alex Zaborski

Faculty Sponsors: Drs. Marilee Ann Benore and Simona Marincean

Abstract

Aromatic and medicinal plants contain chemical components proven to be beneficial for health, and highly utilized in medical, food and industry applications. While used for centuries, the detailed biochemistry of aromatic and medicinal compounds is only now being determined: metabolic synthetic paths unveiled, impact on cellular, metabolic and neuronal paths determined, and potential for use (and abuse) the focus of research globally. The chemical components induce anti-inflammatory, anti-microbial, and physiological influence, as well as induce behavioral and sensory experience that are employed in medical and wellness therapies.

To explore the chemistry and biochemistry of the medical uses of aromatic and medicinal plants, students at the University of Michigan-Dearborn performed biochemical techniques to extract and characterize essential oils of aromatic plants. In this class the specific use of essential oils was explored, students learned to grow plants, and extract and identify specific components (often terpenes) from the extractions. In individual projects students researched, via literature and experiment, a specific aromatic plant to extract the essential oil and characterize its chemical components. The essential oils were extracted via solvent extraction or steam distillation and characterized using Gas Chromatography/Mass Spectroscopy, bacterial contamination, and potential bacterial resistance.

For the final PBL project the students used their chosen essential oils (purchased for safety) to produce commercial products.

Transcriptional Regulation of Ethanol O-Acyltransferase in *S. cerevisiae* Compensates for Genetically Reduced Phospholipid Synthesis

Students: Daniel Ehrheart* and Hussein Alshuhani

Faculty Sponsor: Peter Oelkers, PhD

Abstract

In order to maintain control over its environment, a cell must maintain the composition of its phospholipid membrane. When alterations to the composition of lipids that make up the membrane are detected by the cell, it can initiate a variety of physiological adjustments through the expression of genes to compensate for the changes. One previously observed response by cells with impaired ability to synthesize phospholipids was the significant increase in mRNA abundance of certain genes in the cytosol. This project sought to investigate if there was a link between the translation of a protein compared to the abundance of its mRNA in the cytosol following these alterations to membrane composition. In order to accomplish this, the promoter region of EEB1, one of the upregulated genes, was amplified via PCR and ligated into a yeast integrating plasmid contiguous to the LacZ reporter gene. The relative activity of the LacZ gene could then be monitored through colorimetric assays. Comparing the relative activities between wild type and lipid-compromised cells indicated a possible link between mRNA abundance to corresponding protein and activity. This is of particular importance in *S. cerevisiae* as a regulatory mechanism linking phospholipid

In vitro Analysis of Substrate Specificity of the Human 1-acylglycerol-3-phosphate acyltransferase 4: Implications on Neuronal Membranes

Student: Shadi Kaddah

Faculty Sponsor: Peter Oelkers

Abstract

Lipid metabolism plays a pivotal role in maintaining cellular integrity and function, serving as a foundation for the development and maintenance of neuronal membranes essential for cognitive processes. In the heart of this metabolic pathway, 1-acylglycerol-3-phosphate acyltransferases (AGPATs) emerge as critical enzymes, facilitating the biosynthesis of phospholipids by acylating lysophosphatidic acid into phosphatidic acid, a pivotal step for the generation of cellular membranes and lipid signaling molecules. This project aimed to dissect the specific activities of Lpt1, Slc1, and human AGPAT enzymes under varying conditions, with a special focus on AGPAT4 due to its high expression in neurons. Employing in-vitro lysophospholipid acyltransferase assays, we evaluated enzyme sensitivity to buffer composition and Mg2+ dependency alongside substrate acyl-CoA specificity assays with AGPAT4 expressed in yeast. Preliminary findings reveal that Lpt1 exhibits a robust resistance to changes in buffer conditions, in stark contrast to Slc1, which is significantly inhibited by MOPS buffer. Additionally, Lpt1 activity is diminished in the presence of Mg2+, unlike Slc1, which was not sensitive to Mg2+. Previously, Slc1 showed distinct Mg2+ dependence. AGPAT4 showed higher reaction velocity towards unsaturated lysophosphatidic acids over saturated ones, which suggests a critical role in modulating neuronal membrane dynamics through the selective incorporation of unsaturated fatty acids. Preliminary data on AGPAT3 indicate similar reaction velocities for saturated and unsaturated substrates, though further investigation is required. These results contribute to a deeper understanding of lipid metabolism's impact on neuronal membrane composition, with future potential for novel therapeutic avenues.

TF4.8leW*nBTF8 12 Tf1 0 0 1 72.024 159.62 Tm0 g0 G[( )] TETQ EMC /Span &MCID 20Lang (en-US)11 0

Asymmetrical positioning of cell organelles reflects the cell chirality of mouse myoblast cells

Students: Zeina Hachem *, Courtney Hadrian, Lina Aldbaisi, Muslim Alkaabi

Faculty Sponsor: Jie Fan

Abstract

Cell chirality is crucial for the chiral morphogenesis of biological tissues, yet its underlying mechanism remains unclear. Cell organelle polarization along multiple axes in a cell body, namely, apical-basal, front-rear, and left-right, is known to direct cell behavior such as orientation, rotation, and migration. Among these axes, the left-right bias holds significant sway in determining the chiral directionality of these behaviors. Normally, mouse myoblast (C2C12) cells exhibit a strong counterclockwise chirality on a ring-shaped micropattern, whereas they display a clockwise dominant chirality under Latrunculin A treatment. To investigate the relationship between multicellular chirality and organelle positioning in single cells, we studied the left-right positioning of cell organelles under distinct cell chirality in single cells via micropatterning technique,

Acidification of the Phagosome Orchestrates the Motor Forces Directing its Transport

Students: Habiba Shamroukh, Perla Fares*, Zeinab Bezih, and Muaaz Akhtar

Faculty Sponsors: Suvranta K. Tripathy and Kalyan C. Kondapalli

Abstract

Phagosomes are dynamic organelles formed by macrophages to capture and destroy microbial pathogens. Phagosome transport from the cell periphery to the perinuclear region, is essential for fusion with lysosomes and the elimination of pathogens. Molecular motors, kinesin and dynein, generate opposing forces, transporting the phagosome away from and towards the lysosome, respectively. Luminal acidification plays a crucial role in determining the net directional movement of the phagosome. The mechanics of this regulation are not known. In this study, we used the sodium proton exchanger NHE9 to selectively modulate phagosomal acidification in macrophages and investigated its impact on the mechanical properties of kinesin and dynein motors through optical trapping experiments. We observed a negative correlation between the tenacity of dynein motors and pH under high resistive forces. Reduced phagosomal acidification impaired generation of dynein cooperative forces, which are crucial for transport to the lysosome. Conversely, the kinesin-powered motility of phagosomes is enabled by a decrease in acidification. Given the various methods pathogens employ to limit phagosomal acidification, our findings are highly significant in the context of host-pathogen interactions.

* Presenting student

Exploration of Probiotic Lactobacilli

Students: Thikra Shagir *

Faculty Sponsor: Jolie Stepaniak

Henry Ford College

Abstract

Lactobacilli are a group of lactic acid bacteria that have many health benefits, particularly in the context of probiotics. Probiotics contain live microbes that are introduced into or onto the body to exert beneficial effects. The aims of this study were to evaluate the presence and viability of lactobacilli in a commercial probiotic capsule, investigate their antagonistic effects on the fungus Candida albicans, and explore the inhibitory effects of chemicals produced by lactobacilli on Candida albicans. The research methods involved three main steps: enumeration of viable lactobacilli in the probiotic product through a standard plate count, conducting spot tests to assess microbial antagonism between lactobacilli and Candida albicans, and analyzing the inhibitory effects of cell-free supernatants from lactobacilli cultures on Candida albicans. The results showed that between 1.9 and 3.6 x 106 CFUs (colony forming units) of lactobacilli could be obtained from each probiotic capsule, which fell short of the number claimed by the manufacturer. While the spot

Impact of Fluorene-9-bisphenol (BHPF) Exposure on Embryonic Stem Cell Function and Developmental Gene Expression

Student: Yazan Almahdi*, Eva Schwark

Faculty Sponsor: Besa Xhabija, Ph.D.

Abstract

Fluorene-9-bisphenol (BHPF), a prev(a)421 Yazan Almahdi

-positive Breast Cancer Cells Through the Regulation of Various Signaling Pathways

Student: Aidan McLaughlin *

Faculty Sponsor: Besa Xhabija, Ph.D.

Abstract

Breast cancer remains a leading cause of worldwide cancer-related mortality. Current breast cancer treatments are limited by toxicity, developed resistance, and side effects, necessitating the exploration of novel therapeutics with improved efficacy and reduced toxicity. Spinosyn A (SPA) is a natural product synthesized from the soil bacteria, *Saccharopolyspora spinosa*. SPA is known for its traditional use as an insecticide but has emerged as a promising candidate in the pursuit of improved breast cancer treatments. This study aims to elucidate the comprehensive anticancer effects of SPA on T47- -positive) breast cancer cells, through evaluations of cytotoxicity, cell migration, proliferation, induction of oxidative stress, DNA damage, and genome-wide transcriptional alterations. Our findings demonstrate that SPA significantly inhibits cell proliferation, migration, and induces apoptosis in a dose-dependent manner. Furthermore, flow cytometry and holographic imaging microscopy revealed that treatment with SPA led to cell cycle arrest in the G0/G1 phase, activation of the MAPK and PI3K signaling pathwaD(va)4(ti)192 r 12 Tfxf[(th54.66 43 0 0T2 0 ifinding-1-6,)-sbut 14(a)4(n)-9th54.66substmanti

re[((nti)-3angsnt)-2ud(e)4(n-)] TJETQq0.00000912 0 612 792 reW* nBT/F8 12 Tf1 0 0 1 69.324 68.081 Tm0 g0

Blood brain barrier dysfunction after pediatric traumatic brain injury

Students: Tia Atoui*, Yara Mashal*, Stefanie Tasevski, Amanda Ghannam

Gold nanoparticle-4-Phenylbutyric acid conjugates ameliorate ER stress and

Differential regulation of ER stress and neuroinflammation after pediatric traumatic brain injury

Students: Amanda Ghannam*, Victoria Hahn*, Stefanie Tasevski, Sara Moughni

Faculty Sponsor: Zhi (Elena) Zhang, Jie Fan

Abstract

Endoplasmic reticulum (ER) stress and neuroinflammation play an important role in secondary brain damage after traumatic brain injury (TBI). Due to the complex brain cytoarchitecture, multiple cell types, including neurons and glial cells, are affected by TBI. However, cell type-specific and sex-specific responses to ER stress and neuroinflammatory after brain trauma remain unclear. Here we investigated differential regulation of ER stress and neuroinflammatory pathways in neurons and microglia during the acute phase post-injury in a mouse model of impact acceleration TBI in both males and females. We found that TBI resulted in significant weight loss only in males, and sensorimotor impairment and depressive-like behaviors in both males and females at acute phase post-injury. By simultaneously evaluating the responses in neurons and microglia towards ER stress and neuroinflammation in both males and females, we discovered that the ER stress and anti-inflammatory responses were significantly stronger in microglia, especially in female microglia, compared with the male and female neurons. Whereas the degree of phosphorylated-tau (pTau) accumulation was significantly higher in neurons, compared with the microglia. In conclusion, TBI resulted in behavioral deficits and cell type-specific and sex-specific responses to ER stress and neuroinflammation, and abnormal protein accumulation at the acute phase after pediatric TBI.

* Presenting students

Cerebellar impairment in a mouse model of infantile hypophosphatasia

Students: Stefanie Tasevski*, Sara Moughni*, Amanda Ghannam, Victoria Hahn

Faculty Sponsor: Zhi (Elena) Zhang

Abstract

Mutations in the tissue-nonspecific alkaline phosphatase (TNAP) gene can result in hypophosphatasia (HPP) that is characterized by skeletal and dental hypomineralization. Growing evidence indicates that neurological symptoms are prevalent in patients with HPP. The cerebellum plays an important role in sensorimotor coordination and cognition. However, the impact of TNAP mutation on the cerebellar circuitry development and function remain poorly understood, especially in children with HPP. In this study we in

Generation of two

Bridging the Gap in Pre-Medical Mentorship: The Michigan Medical School Series (MMSS)

Students: Wasey Rehman[1]*, Nadia Aboumourad BS[2], Zahra Patni[1], Zahra Tanana[1], Asil Khanafer[1], Nada Sedrati[1], Yousif Kaakarli[3], Zade Abou-Rass[4], Manas Ponnam[4], Hadi Fayad[5], and Ammar Khan[5]

Faculty Sponsor: Dr. Krisanu Bandyopadhyay

[1] University of Michigan-Dearborn
[2] University of Michigan Medical School
[3] Oakland University
[4] Wayne State University
[5] University of Michigan

Abstract

Magneto-Structural Correlations in New Derivatives of Benzo[*e*][1,2,4]triazinyls

Students: Gabriel Harbauer, Brayden Early, Thomas Smith,

Faculty Sponsor: Christos P. Constantinides

Abstract

Stable organic radicals, with their unique physical properties, stand out as promising building blocks for multifunctional molecular materials. These materials have the ability to amalgamate optical, transport, and magnetic properties, and they can be finely tuned at the molecular level by introducing minor structural alterations in their molecular backbone. Ensuring control of their solid-state packing is crucial to custom tailoring their macroscopic properties, necessitating the development of structure-activity relationships. Recently, we have developed a variety of synthetic routes to air- and moisture-stable Benzo[e][1,2,4]triazinyl radicals (also known as Blatter radicals), aiming to identify correlations between structure and magnetism. Presented herein is a magneto-structural correlation study of newly synthesized Blatter-type radicals.

The Preparation of the Blatter Radical via the Azaphilic Addition of Phenyl lithium to Benzo[e][1,2,4]triazine

Students: B. Early, N. Medawar, K. Chicosky, Y. Aljaber, S. Sheynkop, A. Ahmad

Faculty Sponsor: Christos P. Constantinides

Abstract

Evaluating Seasonal Variations of Sodium, Chloride, Calcium and Magnesium in Water Samples from Rouge River and Fairlane Lake: Effects of De-icing Salt Use on Water Quality

Students: Slater Stanton*, Ashley Benson, Hayden Allie*, Samantha Brunell* and Andrea Sanchez*

Faculty Sponsor: Yiwei Deng

Abstract

The aim of this investigation is to assess the seasonal variability of sodium, chloride, calcium, and magnesium concentrations in water samples collected from Fairlane Lake and the Rouge River, situated adjacent to the Henry Ford Estate. Flame atomic absorption spectrometry (FAAS) was utilized for sodium and magnesium determination, complexometric titration for calcium analysis, and potentiometry with a chloride ion selective electrode (Cl-ISE) for chloride quantitation. The findings reveal significant seasonal fluctuations in sodium and chloride levels within the river samples, exhibiting lower concentrations during summer and autumn, and higher concentrations in winter. However, levels of these elements might decrease compared to those in summer and

A system-orientated concept map extension (SOCME) for sulfuric acid

A system-orientated concept map extension (SOCME) for primary aluminum production

Students: Aaron Engelhardt, Tyler Stewart, and Noah Zain

Faculty Sponsor: Craig J. Donahue

Abstract

This poster presents a system-

Preparation and characterization of a series of bis(bidentate) and tetradentate vanadyl complexes and their use as a catalyst

Students: Brayden Early, Nathan Medawar, Katherine Chicosky, Sofiya Skeynhop, Yakeen Aljaber, and Ahsan Ahman,

Faculty Sponsor: Craig J. Donahue

Abstract

A two-step process was used to prepare a series of $VO(bidentate)_2$ complexes. In the first step, orange V_2O_5 was reduced to blue vanadyl sulfate, $VOSO_4$, in a hot solution containing a mixture of sulfuric acid and ethanol. In the second step, the bidentate ligand (e.g., acetylacetone or 2,4-pentanedione) was added to the $VOSO_4$ solution and then anhydrous sodium carbonate was added until the evolution of CO_2 ceased. The insoluble $VO(bidentate)_2$ complexes were collected by filtration and recrystallized from chloroform. The VO(salen) complex, where salen is a tetradentate ligand containing a pair of N and a pair of O donor atoms, was prepared in an analogous fashion. These blue-green, neutral, paramagnetic, five-coordinate complexes were characterized using several techniques (magnetic moment measurements, electronic spectra, IR spectroscopy, and electron spin resonance spectroscopy (esr)). $VO(acac)_2$ was subsequently used as a catalyst to oxidize anthracene to anthraquinone see below.

The Significance of the Aromatic Stabilization of the Blatter Radical

Students: David Doty

Faculty Sponsor: Daniel Lawson

Abstract

The Blatter radical distinguishes itself as an exceptionally stable radical molecule that has been receiving increased attention in contemporary research. This molecule features three unpaired electrons on its nitrogen atoms; of these, two are spin-paired while the third is delocalized over the molecule. The radical nature of the molecule is thought to be stabilized by resonance delocalization of 3 phenyl rings that effectively surround the radical. In our study, we aim to examine the importance of the aromatic character of each benzenoid ring by substituting them with either non-aromatic rings, such as cyclohexane, or with antiaromatic rings, for instance, cyclopentadiene. By probing into the roots of the Blatter radical's stability, we anticipate uncovering more refined methods to adjust and control the properties of the Blatter radical.

123.69 Tm 0 gG
G1268r.BTt1i(pE0(ra)7(di)-11(c)4(a)4(l)58(n)-9(a
G[(a)4(roma)5(ti)-3(c)4( )10(rings -3(lbDnto-3(22L7dM900(riS1(r.BTt)-3(1i(pE0(ra)7(di)-11(c)4(a)4(l)58(n)-

Cyclopropylmethylidene as a Versatile Protecting Group for Carbohydrate Synthesis

Faculty Sponsor: Xiaohua Shannon Li

Abstract

Complex carbohydrate synthesis requires the availability of diverse and orthogonal protecting strategies for common functional groups, such as hydroxyl, amino and carboxyl groups. Besides masking necessary functional groups, it is well-known that protecting groups also greatly impact the reactivity of glycosyl donors and acceptors and the stereoselectivity of glycosylation reactions. We recently developed cyclopropylmethylidene (CPMD) as a versatile protecting group for carbohydrate synthesis. It can be formed by acid-catalyzed acetalization between cyclopropanecarboxaldehyde and 1,3-diols of sugar molecules. Selective reductive opening of the 4,6-*O*-cyclopropylmethylidene can be achieved to afford a C4 free hydroxyl group and a C6-cyclopropylmethyl (CPM) ether or vice versa. The cyclopropylmethylidene was found to be less stable than benzylidene under acidic conditions. In addition, cyclopropylmethyl (CPM) ether may be deprotected using trifluoracetic acid in dichloromethane.

* Presenting student

Earth and Environment

Exploring the Conservation Dynamics and Habitat Ecology of Antillean Manatees in Belize

Student: Christian Cannon *

Faculty Sponsor: Ulrich Kamp

Abstract

Antillean manatees (*Trichechus manatus manatus*) are globally acknowledged as an endangered species and serve as a vital role to the aquatic ecosystem of Belize in Central America. Despite their ecological significance, Antillean manatees face numerous conservation challenges, including habitat degradation, anthropogenic threats, and the impacts of climate change. In this study, we conducted a comprehensive investigation into the conservation dynamics and habitat ecology of Antillean manatees in Belize. Through a multidisciplinary approach, we utilized scientific literature, satellite imagery, and data analysis techniques. Our findings highlight the

Preliminary Density Functional Theory Study of Organophosphorus Compounds and the Reactivity with Serine Amino Acids

Students: Sumaiyya Mujawar*

Faculty Sponsor: Prof. D. Lawson

Abstract

Acetylcholine is a key neurotransmitter involved in various physiological processes, including muscle contraction, regulation of heart rate, and modulation of cognitive functions. Acetylcholinesterase is present at the cholinergic sites refer to specific locations in the body where the neurotransmitter acetylcholine (ACh) exerts its effects by binding to receptors. Acetylcholinesterase (AChE) belongs to a category or group of enzymes known as serine hydrolases. The primary role of AChE is to terminate neuronal transmission and signaling between synapses to prevent ACh dispersal and activation of nearby receptors. Organophosphates for a group of mostly synthetic compounds that inhibit AChE and form are an economically important component of pesticides and nerve agents for the agriculture industry. Whereas, organophosphates are synthetically derived, little is known about how they inhibit nerve reception.

This work uses Density Functional Theory to examine the nature of a group of organophosphates to assist in elucidating the reaction mechanism between organophosphorus (OP) insecticides and the serine amino acid. The aim is to gain insights into the molecular mechanisms underlying the possible interactions between OP and the biological active sights, focusing on properties such as dipole moment, electrostatic potential, Highest Occupied Molecular Orbital (HOMO), and Lowest Unoccupied Molecular Orbital (LUMO) values. By employing quantum mechanical computational methods of DFT, we elucidate how OP insecticides interact with serine at the molecular level. Our findings reveal significant variations in dipole moments among the studied compounds, indicating differences in polarity and charge distribution. Overall, our analysis provides valuable information for understanding the behavior and reactivity of organophosphorus compounds, with implications for pesticide development, environmental monitoring, and pharmaceutical research.

Microbiology

The Use of Attenuated Total Reflectance Fourier Transform Infrared (ATR-FTIR) Spectroscopy to Analyze Pb-Induced Changes in Bacterial Strains

Students: Amin Kassem, Somie Opara
Faculty Sponsors: Shannon Li and Sonia M. Tiquia-Arashiro

Abstract

Microorganisms can effectively remove Pb from aqueous solutions through biosorption and the functional groups in their cell walls are responsible for the binding tasks. However, the success of biosorption relies on the diversity of cell wall structures. ATR-FTIR spectroscopy was used to identify the functional groups involved in Pb uptake of four bacterial strains (R3, R19, L2, and L30) grown in different concentrations of Pb (0, 10, 100, and 500 mg/L of Pb). FT-IR profile of Pb-free bacterial strains displayed various peaks corresponding to functional groups. When the cells were treated with Pb, some functional groups shifted, and some new peaks appeared. The number of IR shifts varied between strains. More shifts were observed for R2 and R19 (10-14 IR shifts) than L2 and L30 (8 IR shifts). These functional groups include: $(RCO)_2O$, C-C, $R_2C=O$, RCOOH, C $_2HR_3$, monosubstituted, and 1-3 disubstituted aromatic compounds. The appearance of new IR peaks was more evident when cells were grown at 100 mg/L Pb. These IR peaks correspond to functional groups such as $C_2H_2R_2$, C_2H_3R, R-OH, RCOCl, R-OH hydrogen bonded, $R_2C=NR$, R_2

$_2$, P=N, Ar-H, 1-2 and 1-4 disubstituted aromatic compounds. This study showed significant changes in the functional groups when exposed to Pb which might be responsible for the biosorption of Pb by the strains.

SEM-EDS and TEM-EDS Analysis of Zn Biosorption Characteristics of *Klebsiella* sp. and *Raoultella* sp.

Students: Claudia Shuler, Grace Pagnucco, Somie Opara, Amin Kassem

Copper Biosorption by Siderophore-producing Bacterial Strains

Students: Diana Kasperek, Claudia Shuler, Grace Pagnucco, Amin Kassem, Hawraa Najaf, Somie Opara, Oliver Coutinho, Lana Abbas.

Faculty Sponsor: Sonia M. Tiquia-Arashiro

Biosorption mechanisms of metal removal by bacterial strains

FT-IR Spectroscopy for the Identification of Binding Sites for Cr absorption in Bacterial Strains

Students: Lana Abbas, Amin Kassem, Oliver Coutinho, and Hawraa Najaf.

Faculty Sponsors: Shannon Li and Sonia M. Tiquia-Arashiro

Abstract

Chromium (Cr) contamination presents significant environmental and health hazards, necessitating a thorough understanding of its interaction with bacterial strains for effective remediation approaches. In this investigation, Fourier-transform infrared (FT-IR) spectroscopy was used to examine the binding sites responsible for Cr absorption in four bacterial strains (R3, R19, L2, and L30). The primary objective was to identify the functional groups involved in the binding process, thereby offering valuable insights into the mechanisms of Cr uptake. The bacterial cultures were exposed to 10 mg/L of Cr and FT-IR spectroscopy was utilized to record their spectra. The acquired spectrum underwent meticulous data analysis, encompassing peak identification and analysis. The FT-IR spectra of the bacterial strains exhibited changes in the intensity and position of specific absorption bands following Cr exposure. By means of peak identification and reference spectrum comparison, functional groups such as 1,3-disubstituted and 1,2-disubstituted aromatic Compound, alkenes ($C_2H_2R_2$) hydroxyls (R-CHO, R-OH), amines (C-C), and N- and P-containing functional groups (P-NH_2, P=N, P-NH), were identified as plausible binding sites for Cr absorption across all bacteria strains. This study collectively shows the effectiveness of FT-IR spectroscopy in the binding sites accountable for Cr absorption in bacterial strains. The integration of peak identification shows an analysis of the

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Electron Microscopy Techniques and Energy Dispersive X-ray Spectrometry as Tools to Characterize Biosorption of Lead by Bacterial Strains from an Urban Watershed

Students: Somie Opara, Grace Pagnucco, Claudia Shuler, and Hawraa Najaf

Faculty Sponsor: Sonia M. Tiquia-Arashiro

Abstract

For many bacteria, biosorption is a mechanism that allows heavy metals like lead (Pb) to be removed from bodies of water. To understand the mechanism of this process, this study was conducted to determine the biosorption capacity of Pb uptake of two bacterial strains, *Klebsiella sp.* (R19) and *Raoultella planticola* (L30), isolated from the St. Clair Lake. Multiple techniques were employed to understand the biosorption process and the structural and biochemical characteristics of the strains, including: FTIR spectroscopy, STEM-EDS assay, MIC assay, and siderophore assay. The FTIR analysis indicated that biosorption of Pb is achieved through binding -EDS analysis showed that biosorption of Pb can also occur via extracellular polymeric substances (EPS) secreted from microbes as well as intracellularly. Both of the strains were resistant to Pb as both required a relatively high concentration of Pb before showing signs of growth inhibition (MIC = 800 mg/L) and were also observed to produce more siderophores with increasing Pb concentrations. The EPS and cell wall facilitated ion exchange and metal chelation-complexation by virtue of the existence of ionizable functional groups such as carboxyl, sulfate, and phosphate present in the protein and polysaccharides on the cell surface. The siderophores facilitated the accumulation of Pb in the cytoplasm. This highistcytoplasmpl-

Transformation of *Escherichia coli* HB101 K-12 with a high-copy number plasmid (pGLO) encoding the green fluorescent protein

Students: Sufyan Abdalla and Vaughn Karaim

Faculty Sponsor: Sonia M Tiquia-Arashiro

Abstract

Chemotaxis Behavior in *E. coli* in Response to Different Chemical Stimuli

Students: Reeghan Book, Zainab Nassereddine and Erica Parmenter

Faculty Sponsor: Sonia Tiquia-Arashiro

Abstract

Chemotaxis, which allows bacteria to detect and move in response to chemical gradients, is fundamental for their survival and behavior. In this study, we investigated *E. coli* chemotactic behavior in response to various chemoeffectors. Capillaries containing these chemoeffectors were placed in chemotaxis chambers containing *E. coli* and incubated for 1.5 hours at 30°C. After incubation, cell migration into the capillary tubes was compared with the control (chemotaxis buffer) using serial dilution and spread plate techniques. Overall, our group findings revealed distinct responses in chemotaxis assays. Glycerol and aspartate were identified as repellents with migration percentages of 0.044% and 0.018%, respectively. In contrast, galactose, leucine, and the chemotaxis buffer acted as attractants with migration percentages of 1.698%, 4.341%, and 1.045%, respectively. This deviates from the expected results described in the literature where galactose, glycerol, leucine, and aspartate, are typically regarded as attractants. However, their effects can vary with chemoeffector concentration and cell population density. We suspect the deviation in

Streptomycin and Tetracycline Resistance Acquisition in *Serratia marcescens* and *Micrococcus luteus* via Spontaneous and Induced Mutations

Students: Nazik Ebrahem and Florent Qyteti

Faculty Sponsor: Sonia M. Tiquia-Arashiro

Abstract

Bacteria can experience induced and spontaneous mutations. Induced mutations occur when bacteria are intentionally exposed to harmful conditions, such as ultraviolet (UV) light. On the other hand, spontaneous mutations occur naturally and are difficult to detect unless a selecting agent is present, like an antibiotic. We aim to investigate the effect of induced mutations on p8 0 1 246.89 543.07 Tm92 reW* nBT/F8 12ETQq0.00000912 0 61 2 79751ntion3ons

Physics

Role of Ellipticity on Spin Dynamics of Ferromagnetic Nanorings

Students: Yassin Elmeligi *

Faculty Sponsor: Bushra Hussain

Abstract

Ferromagnetic nanorings are of great interest within condensed matter physics due to the presence of two stable states within them-the vortex state and a mediating onion state. The low-field vortex and higher-field onion states are additionally denoted by an abrupt change in spin wave (SW) frequencies at the transition field between the two orientations. The accommodation of these states within ferromagnetic nanorings allows for their application within a range of fields such as biomedicine, materials engineering, computer science, and computer engineering. Beyond the existence of the vortex and onion states, the SW spectra and transition fields between the two states can be controlled by factors such as geometry and applied field. Elliptical nanorings have been fabricated and studied for their effect on SWs through methods such as Brillouin light scattering.

Our computations modify a Hamiltonian based formalism developed for circular nanorings to elliptical permalloy nanorings. We study the influence varying the ellipticity of a nanoring has on the spin dynamics of the nanoring. In addition, we analyze the influence of rotating the nanoring with relation to the applied field has on its SWs and transition field between the vortex and the onion states. Our results find a strong dependence on nanoring orientation in relation to the applied field for the SW frequencies in an elliptical geometry. Additionally, we find that SW frequencies exhibit a dependence on the ellipticity of the nanoring.

* Presenting student

Spin Dynamics of Ferromagnetic Nanorings

Students: Aishwarya Seetharaman * and Musada Algaithi

Faculty Sponsor: Bushra Hussain

Abstract

Ferromagnetic finite structures of nano-size scale have been extensively studied due to their wide range of applications, such as bio(sensors), data storage devices, signal-processing and logic systems, microwave devices and spintronics. Of such structures, circular nanorings are of particular interest in part due to their circular symmetry, which is advantageous in high-frequency switching, logic and storage devices. A distinct feature of these nanorings is the existence of two stable magnetization -19(na)5ts,ETQq0.00000912 0 612 792 reW* nBT/F8 12 Tf1 0 0 1 263.33 568567 Tm0 g0

Approaches to Analyzing Movement of Intracellular Organelles

Students: Emily Leich*

Faculty Sponsor: Dr. Nicholas A. Licata

Abstract

Analyzing the in-vivo motion of intracellular organelles presents a number of significant challenges. Molecular cargo is subject to both thermal motion inside the cell, as well as directed motion caused by the processive walking of molecular motors to which it is tethered. The molecular motors walk along a cross-linked microtubule network, which plays the role of an intracellular organelle highway. We consider methods for analyzing intracellular transport when only the position of a bead acting as cargo within the cell can be seen. In this experimental assay, the microtubules and motors cannot be seen or tracked, so the focus of the method described here is to analyze the motion of the cargo. The position of the bead was tracked within two different cell types, both wild type cells and cells with a modification to the expression level of the NHE9 protein. A maximum likelihood approach based on changepoint theory is able to parse an individual trajectory into statistically similar segments, for which cargo velocities and diffusion coefficients are calculated. The choice of changepoint algorithm parameters is made based on an analysis of simulated data generated from the Langevin equation. The approach is applied to in-vivo experimental data from both wild type and mutant cells. The resulting distributions characterizing the statistics of cargo transport between the two cell types were compared. The results of this research show that the motion of intracellular organelles is empirically different in cells with modified NHE9 expression levels as compared to wild type cells.

* Presenting student

Mechanical regulation of kinesin at varying pH

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Faculty Sponsors: Suvranta K. Tripathy

Abstract

Kinesin-1, a plus-end microtubule-