**SYMPOSIUM OF THE CITY COLLEGE IMMERSIVE RESEARCH AND CREATIVITY**

**LEARNING EXPERIENCES**

**(CIRCLE) PROGRAM**

## City College of New York



Supported with funding from New York State, NSF REU, the City University of New York, and Stuart Z. Katz

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**INTRODUCTION**

While fewer classes are offered during the summer months at City College and the campus is quieter, summer is a time of great creative and intellectual activity at City College, as students have opportunities to pursue immersive experiences in creativity, scholarship, and research. Working closely with faculty mentors, undergraduates engage in discovery in libraries, in laboratories, in studios, in the field, and in working with community partners. We are proud to showcase a sampling of the projects our undergraduates worked on this summer. Please note that since the purpose of this program is to highlight the work of undergraduates, presenting student authors are listed first in the abstracts below.

# DIVISION OF HUMANITIES

**& THE ARTS**

## Lives of the Theorists

### Aeriel Badiola and Harold Veeser Department of English

*The Greatest Generation* is a project that aims to synthesize twenty scholars and their contributions in literature. Furthermore, it demonstrates the importance of literary study, and its impact on a plethora of societal constructs-- from middle class society conversation, academia, to becoming fundamental points in feminism, The Lesbian, Gay, Bisexual, and Transgender movement, to African-American studies. Scholars of varied specialties in literature have been synthesized in this piece not only to showcase their theories and major contributions, but to also showcase and include biographical information on these scholars, how they operate, and how they continue to contribute to the conversation in their respective subgenres of literature. Biographical information of the twenty different scholars were collected to showcase what kinds of works these scholars have produced and to cultivate a more well-rounded perspective on their specialties. In the biographical research that was conducted, the majority of these academics received their doctorate degrees in the 60s-80s. It was during this time that conversation on theories such as poetics, deconstructionism, hybridity, etc. were constructed and had a big impact on literary theory moving forward. In interviews, biographical information, and literature that were researched, the idea of blurring the binary has been addressed—the content that was produced in these time periods were during times of revolution and dramatic change in society such as epidermal classifications and social constructions of gender; on the world stage, post colonialism was being addressed. Although these scholars worked on different subgenres, the content was produced from a time period in which binaries were merging. These theories in all the different specialties have been influential ideas on society and have started the conversation in all types of settings. Further research on *The Greatest Generation* can be conducted in trying to further synthesize the societal aspects in which these scholars were writing in.

## Earth and Water: The Importance of Rock Art and Rain-Making in precolonial Chewa Society

### Lywana Dorzilor and Andrea Felber Seligman Department of History

The purpose of this project is to get a better understanding of the notions of health and spirituality from one of Malawi’s more influential ethnic groups using rock paintings attributed to Chewa agriculturalist from the 1st Century CE to the early 20th Century. There has been a lack of focus on Rock Art in general as a way to understand the construction of spirituality and health among the Chewa and many ethnic groups that Rock Art has been attributed to. I used an array of methods to complete this research project. This included reading certain books related to this topic, using several different databases like WorldCat and JSTOR to find past research conducted on this topic, and using the website Trust for African Rock Art (TARA) to look at the late-white paintings of Malawi. My research shows that to these Chewa agriculturalist rain and rain-making was vital to the notion of spirituality and water was and still is an important and sacred aspect to health. Rain-making was fundamental to early Chewa notions of spirituality. Water continues to be an essential part of agricultural societies, in addition to its sacred healing attributes. There seems to be a strong link between the zoomorphic late-white painting, rain and water, and initiation rituals and secret societies and their importance to Chewa spirituality and healing. However, there still needs to be more research conducted to better understand these connections.

## Medieval Literature and the Transgender Existence

### Jared Heron Department of English

The LGBT community has fought for their right to be accepted in society and even further to just prove that they exist and that they always have existed. It is commonly accepted knowledge that the “LGB” portion of the queer minority has always existed. But what of the “T”? There are many under the false impression that being Transgender is something new to the world and not something that has been a part our culture throughout history and literature. My research aims to prove the old age of the presence of Transgender individuals and concepts in our culture by examining one of the earliest periods in history: the medieval era. Historical figures such as Joan of Arc and the Roman slave Sporus and the possibility of such individuals being Transgender will be explored. Medieval literature such as the *Lais of Marie de France* and Heldris of Cornwall’s *Le Roman de Silence* will be examined for traces of the Transgender existence. Where there is an argument that a historical figure may have been cross- dressing, I intend to provide my rebuttal of “Why not Transgender?” My research will explore what the medieval definition of being Transgender is whilst comparing the beliefs of that time with those of today. We comb through medieval author’s written work that reveals concepts that support the Transgender identity. My hope is that through this research, myths about Transgender individuals’ place historically will be dispelled and that it may provide insight to even the modern interpretation of what it means to be Transgender.

## A Glimpse Towards Conservation of Newtown Creek

### Olga Shcheglova, Mathew Brown, and Patterson Beckwith  Department of Art

New York City has one of the most developed infrastructures in the country that provides its residents with comfortable living conditions. However, there are plenty of negative effects such an evolved network imposes on various communities and highly fragile ecological systems around the city. One of the best places to evaluate the damaging effects of infrastructural pollution is the very border of Queens and Kings counties, in the waters and shores of Newtown Creek. The creek also serves as a base to the Newtown Creek Alliance (NCA), in collaboration with which we conducted our research in the June-August of 2017. The group works to restore wholesomeness of the local ecosystem and to educate the community about the ways to protect the creek. These objectives resonated with us and therefore, we chose to build awareness of the Alliance’s efforts by documenting them.

After a number of visits and boat trips along the waterway, our team has witnessed many issues that the Alliance is trying to resolve, such as:

* + negative impact of aeration on air quality and safety;
	+ undesirable occurrence of Combined Sewer Overflow (CSO) in the waters;
	+ hazardous concentrations of waste from waste transfer station on the shores of the creek

By documenting the aeration sites, CSO events and flows of waste and litter on the surface of the water and along the shore, we created the evidence of exemplary efforts that NCA has been conducting to protect and preserve the waters of the creek. Our research brought us to witness the Alliance’s collaboration with LaGuardia CC in building and maintaining a network of marsh grassess that are designed to reintroduce the native plants to shorelines of the creek. The collaboration helps conduct weekly water quality sampling that is essential to keeping Newtown a viable habitat for a wide variety of plankton, fish, migratory and native birds and mammals.  As a result of our research, our team created a selection of photographs that offer a closer look at one of the corners of New York City whose existence is endangered by the ever-evolving infrastructure. By showcasing the efforts of Newtown Creek Alliance we wish to address the importance of ecological education among city residents and promote conscious co- habitation.

## The Prophylatic City

### Michael Anthony Villanova Department of Philosophy

The study of critical geography focuses on how economic, cultural, and social factors impact spatial relations in terms of human geography. Historically, urban spaces have been understood as important centers of production, class relations, and modernization that create a certain way of life for those living in them. This research of “The Prophylactic City,” seeks to understand the recent trends in urban geography as city spaces become geared towards consumption and the cultural implications for how everyday life is sculpted. This research uses the history of contemporary New York City, sociological studies of geography by Alex Vitale and Edward Soja, and the philosophies of Henri Lefebvre, Soren Kiekegaard, and Jean Baudrillard to put forward the claim that the everyday life and the culture produced by this new type of city is, in a word, prophylactic. This research asserts four points on contemporary urban spaces. First, that in contemporary geographies there is a correlative link between the destruction of housing movements and affordable housing, in relation to the rise of neoliberal economics. Second, that with the rise of neoliberal economics there is a return to policing mannerisms and attitudes and a strengthening of the government’s control over how people should act in an urban space. Third, through governments implementing policies that favor the consumption of certain commodities, large companies own more and more land and that this reliance on knowable companies that are not unique to the city itself have created a “safety-first” attitude and “prophylactic aesthetic experience” that destroys the ludic nature of urban spaces. Fourth, this research connects the economic effect on urban spaces to recent developments in technology and wider social trends that have made city dwellers boring, relying on corporations for identity, and unable to address the material and abstract problems facing them.

# COLIN POWELL SCHOOL OF CIVIC AND GLOBAL LEADERSHIP

## Yonkers and New Rochelle: An Exploration of Suburban Transformation

### Mariah E. G. Cameron and R. L’Heureux Lewis-McCoy Department of Sociology and Program in Black Studies

My summer research project with ORCA under the supervision of Dr. R. L’Heureux Lewis-McCoy in the Department of Sociology and Black Studies program delved into the past and present of Yonkers and New Rochelle to explore the changing nature of the suburban experience. I developed skills such as: literature searches and review, database creation, and university-community relationship building. The larger project asks: How can some live with extreme advantages while others live in severe poverty just streets away? How have schools responded to changing demographics?

At 20.3 square miles and 371 years old, the city of Yonkers has a hauntingly rich history. Yonkers holds the distinction of being one of few cities to ever have the federal government intervene on a 40-year pattern of racialized sighting of public housing and school segregation. While Yonkers’ legal civil rights battle is well known, its neighbor New Rochelle has experienced similar issues of racially restrictive housing and school attendance policies. However, New Rochelle was not legally forced to address race and class related civil rights issues. By looking at both communities, we can gain greater insight into how race, class, and place matter for the suburban experience. These two communities are exemplars of how diverse suburban communities and experience. This summer I worked to build two databases that contained articles on the issues of housing and school segregation in Yonkers and New Rochelle. I searched databases for the New York Times for both municipalities and created a searchable database that allows Professor Lewis-McCoy to capture the arch of the civil rights struggle in these communities. Additionally, I attended meetings with our research partner organization—Community Voices Heard—to gain a greater understanding of how research is conceptualized and how it may be mutually beneficial for university and community.

# DIVISION OF SCIENCE

## DNA replication initiation: on cooperativity of initiator binding to the replication origin

### Dhanjai Brown, Natalia Orlova, and David Jeruzalmi Department of Chemistry and Biochemistry

The majority of bacteria possess a single circular chromosome that stores the entire bacterial genome. Chromosomal DNA replication in bacteria requires a specific site on bacterial chromosome – origin of replication, and a specific protein – the replication initiator. In addition to indispensable chromosomal DNA, bacteria possess small circular DNA molecules, called plasmids. Plasmid replication also requires a specific site on a plasmid – plasmid replication origin and an initiator protein that structurally is different form the chromosomal initiator protein. Unlike most of bacteria V. cholerae has two circular chromosomes, and replication of the second chromosome requires unique factors. In particular, replication of the second chromosome in V. cholerae requires a unique initiator protein RctB. In Jeruzalmi lab the structure of the fourth and final domain of the replication initiator protein, RctB, has been solved. Now that we know what it looks like, what exactly does it do? Since it is a part of an initiator protein, there is a good chance that it assists in that regard. However, it could carry out additional functions such as stabilizing the entire complex or improving binding efficiency. By creating and experimenting with various mutants, one can uncover the full extent of this domain’s functions.

## Expression and Purification of C- terminal Truncated λO for Future Structural Studies

### Chloe Chai, Jillian Chase, David Jeruzalmi Department of Chemistry and Biochemistry

DNA replication is important to living organisms as it transfers valuable genetic information to future offspring. Replication comprises of three main steps, initiation, elongation and termination, which can be found across all three domains of life. In bacteria, initiation proteins are conserved which suggests conserved mechanism. Bacteriophage λ infects encodes two initiation proteins λO and λP used in replication as other proteins needed are provided by the host cell. λO is known to bind to DNA at the origin *oriλ* but how it recognizes and binds to the DNA strand is unknown.

The λO protein is a 34 kDa sequence specific DNA binding protein with 299 amino acids λO dimerizes and binds to the origin of replication and initiates replication, recruiting λP, which acts as the helicase loader for bacterial helicase DnaB. The λO protein is composed of two domains; the N-terminal interacts with the λP protein while the C-terminal interacts with the DNA origin. λP interacts weakly with *oriλ* bound λO, but it forms a tight complex with DnaB. At the origin, four λO dimers can bind, and the A/T rigion to the right of the λO binding site is required for formation of stable λO-λP-DnaB complex.

Truncated and full-length constructs were propagated and sequenced, then grown, induced and expressed. Truncated construct λO, amino acids 156-299 with a 6x Histidine tag has been shown to successfully transform, induce and grow. Early purification trials have shown the presence of two proteins of which we are unable to distinguish our protein of interest.

## Exploring Transcriptional Regulation of the Onecut1 Gene

### Ariana Gopal, Sruti Patoori, Mark Emerson Department of Biology

The retina is located in the inner layer of the posterior eye. It is responsible for converting light into electrical impulses, and transmitting these impulses through the optic nerve and to the brain for processing. Multipotent retinal progenitors differentiate into various retinal cell types, each with a unique function. Proteins known as transcription factors are responsible for regulating development and differentiation of these cells. An early genetic marker that has been linked to differentiating retinal progenitor cells into cone photoreceptor cells, responsible for visual acuity and detecting color, is thyroid hormone receptor beta (Thrb). Thrb *Cis*-regulatory Module 1 (ThrbCRM1), an enhancer linked to Thrb regulation, has demonstrated activity in retinal progenitor cells that give rise to both cone photoreceptors and horizontal cells. Two transcription factors, Otx2 and Onecut1 (OC1), bind to this enhancer region to regulate the expression of Thrb. Past research has suggested that misexpression of the OC1 gene leads to the expression of early cone and horizontal cell markers and is also responsible for suppressing rod genesis. Though OC1 is crucial for cone and horizontal cell differentiation, little is known about what enhancer regions are necessary for regulating transcription of the OC1 gene. The purpose of this project is to evaluate the role of accessible chromatin region 10 (ACR

10) in regulating the expression of Onecut1. Because the ACR is over 2000 base pairs, fragments of ACR 10 were individually ligated into the Stagia3 vector, and electroporated into chick retinae at embryonic day 5 (E5) and harvested at E7. Alkaline phosphatase (AP) staining of these retinae suggests that the fragments of this ACR sequence are responsible for regulating gene expression in the chick. Future research is needed to determine if ACR 10 specifically regulates OC1.

**Role of *moa-1*, an anti-phosphatase, in male tail morphology and mating behavior in *Caenorhabditis elegans***

### Valerie Moscoso and Chris Li Department of Biology

Alzheimer's disease is a neurodegenerative disease that affects more than 30 million people globally. The disease is characterized by an accumulation of beta- amyloid peptide plaques in the brain. The beta-amyloid peptide is derived from a larger precursor protein, the amyloid precursor protein (APP). Mutations in APP have been correlated with Alzheimer's disease. Due to the presence of two paralogues, APLP1 and APLP2, with overlapping functions, the normal function of APP is difficult to elucidate. Knockout of the entire APP gene family in mice results in lethality and developmental defects, indicating that the APP gene family has an essential function.

The nematode *Caenorhabditis elegans* has only one APP-related gene, *apl-*

*1*. *apl-1(yn10)* knockouts are not viable, indicating that *apl-1* has an essential function. *apl-1(yn5)* mutants are the only viable allele; these mutants produce only the extracellular domain of APL-1, which alludes to its importance. However, *apl- 1(yn5)* mutants have many phenotypic defects, which include poor mating, delayed development, and lethality at high temperatures. *moa-1* mutations suppress the *apl- 1(yn5)* lethality. Surprisingly, overexpression of *moa-1* disrupts male tail development; the male tail is critical for successful mating. This investigation is a blind study that characterizes the phenotypic defects present in the adult male tail of these mutant and transgenic animals as well as any behavioral defects present during mating. By identifying these defects in *C elegans* and the pathways in which they function, we will be able to better elucidate the function and pathway of the human APP gene.

## A Polar Look at Temporal Resistance: Antibacterial Assessment and Metabolite Profiling of Polar Wound- Healing Tissue Extracts from Different Potato Cultivars

### Mathiu Perez Rodriguez, † Keyvan Dastmalchi, † Janni Lin, £ and Ruth E. Stark †§\* † Department of Chemistry and Biochemistry, The City College of New York, City University of New York and CUNY Institute for Macromolecular Assemblies, New York, NY 10031, USA £ Hunter College High School § Ph.D. Programs in Chemistry and Biochemistry, The Graduate Center of the City University of New York, New York, NY 10016

*Solanum tuberosum*, known as the potato, is a major worldwide food staple. During harvest, collection, storage, and distribution the crop is at risk of mechanical damage. Wounding of the potato skin can become a point of entry for bacterial and fungal infection. *Erwinia carotovora* is a rod shaped gram-negative bacterium that infects potatoes and results in massive crop waste. The objective of the current investigation was to compare potato cultivars with different russeting features in terms of defensive function and its underlying chemical basis: (1) to assess the antibacterial activity of the polar extracts against *E. carotovora and E. coli;* and (2) to determine the metabolite composition in polar wound tissue extracts at various wound-healing time points (days 0, 1, 2, 3 and 7). The identification of metabolites was assessed by processing LC-MS data with two different software packages utilized for data normalization and metabolomics statistics. The quantification of biomarkers was conducted for each specific cultivar. Our findings indicate that identified biomarkers mainly belong to five compound classes: phenolic amines, phenolic acids, amino acids, glycoalkaloids and flavonoids. Extracts from earlier wound-healing time points (days 0, 1, 2), at which formation of the wound periderm protective layer is less complete, show notably higher abundance of phenolic acid and amino acid markers for the most russeted cultivars (Norkotah Russet and Atlantic). The glycoalkaloid marker concentrations increase at later wound-healing time points (days 3 and 7) for the most russeted cultivar, while no change in the concentration of these types of markers is detected during the wound healing process for the least russeted cultivar, Yukon Gold. These findings, when correlated to our prior work, provide a rationale for the burst of antibacterial compounds at early time points in the most active extracts: Norkotah Russet day 0 and Atlantic day 7 against *E. coli*, and Atlantic day 0 against *E. carotovora*.

## The Non- Additivity of the Electrostatic and Hydrophobic Binding Energy of Indolicidin in Lipid Bilayer

### Sumayya Shurovi, Themis Lazaridis, and Binod Nepal Department of Chemistry and Biochemistry

Proteins bind to both specific and nonspecific sites of cell membranes. Electrostatic and Hydrophobic interactions are responsible for the nonspecific binding of these proteins. It was proposed that if the Electrostatic and Hydrophobic energies were simply additive, then the observed free binding energy would be the sum of their free energies. However, these interactions are not simply additive especially for larger molecules. To examine the effect of hydrophobicity on the Electrostatic forces of the anionic membranes, their binding energy could be compared to the calculated binding energy. For the experiment, 10 variants of Indolicidin were used. Indolicidin is a 13- residue, cationic proline- rich antimicrobial peptide. It was bonded to two types of anionic lipid membrane POPC and POPG to examine their binding with the lipid membranes, and to compare their binding energy trend with the calculated binding energy. The variants were bonded to the lipids by the use of various models in Linux command. IMM1 and GBSW were most efficient for binding most of the variants with reasonable binding energy when compared to the other structural models used such as Straight chain and Alpha helix, and PDB. Some of the variants seem to be out of the membrane boundary which is in the range of +13.5MeV to -13.5MeV. After comparing the calculated data with the expected and the experimental data using Wimley-White interfacial hydrophobicity scale, the calculated value were much higher. The structures of the variants were loaded by using a molecular visualizing program called VMD which showed the binding of the protein with the lipids. It was evident from the results that there is a linear relationship between the Hydrophobic and Electrostatic forces of the peptides which could further explain the additivity of various peptides.

## Cryo-Electron Microscopy study of Luteovirus cap-independent translation element (BTE) with Eukaryotic Initiation Factor (eIF) 3

### Elizabeth Soto, Danya Ben-Hail, and Amédée des Georges Department of Chemistry and Biochemistry

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Viruses have been the cause of millions of deaths. These pathogens have multiple ways to infect well-functioning cells and one of these ways is using a cap- independent translation element (CITE). Barley yellow dwarf virus (BYDV) is the most widely distributed plant virus among cereals. It affects important crop such as oats, wheat and rice. BTE (BYDV translation element) is a CITE located in the 3’ UTR of its mRNA and It has been found to bind to Eukaryotic Initiation Factor (eIF) 4G, a protein involved in translation initiation. The purpose of these CITE’s is to start translation without the 5’ cap. BTE ”tricks” eIF4F into telling the ribosome the 5’ cap is there. Eukaryotic Initiation Factor (eIF) 3 is a complex that functions during eukaryotic translation and it is essential for most of cap-dependent and cap-independent translation Initiation. eIF3 has been found to bind to elF4G.

# CUNY SCHOOL OF MEDICINE

## Relationship Between KIF17 and Na, K- ATPase in C2C12 Muscle Cells

### Akhila Chilakala, Aleksandra Alimova and Geri Kreitzer Department of Molecular, Cellular and Biomedical Sciences

The kinesin motor KIF17 participates in protein trafficking in neurons and epithelial cells, and regulates cytoskeletal dynamics and epithelial polarization, but its function in other cell types is unknown. We found that KIF17 is expressed at high levels in skeletal muscle and that it interacts with the Na,K-ATPase, a key regulator of muscle function. We hypothesize that KIF17 functions in muscle to regulate the localization of Na,K-ATPase; it may also function in myogenesis by regulating changes in the cytoskeleton that accompany muscle differentiation. Here, we show that KIF17 localizes to radial microtubules in myoblasts and along longitudinal MTs in differentiated myotubes. In myoblasts, Na,K-ATPase localizes in cytoplasmic puncta and to the plasma membrane. In myotubes, Na,K-ATPase fluorescence increases dramatically and the protein appears throughout the myotubes as well as in discrete structures near the periphery of these fibers; these structures may reflect the reported localization of Na,K-ATPase in T-tubules. We are testing if KIF17 has a role in regulating Na,K- ATPase localization by monitoring Na,K-ATPase localization in cells overexpressing dominant negative and constitutively active mutants of KIF17. Expression of these mutants is expected to alter Na,K-ATPase distribution if KIF17 regulates transport and delivery of Na,K-ATPase. Moreover, we are testing the effects of expressing KIF17 and KIF17 mutants on the distribution of newly synthesized Na,K-ATPase introduced into cells by microinjection. Together, these experiments will allow us to determine if KIF17 plays a role in localizing Na,K-ATPase in muscle cells. Future experiments will test if the effects of KIF17 on Na,K-ATPase also impact muscle cell function.

## Balancing Neurodegeneration and Neuroprotection in a *C. elegans* Model of Excitotoxicity: A study of CREB’s coactivator, CRTC

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Excitotoxicity is a major cause of neurodegeneration in stroke and other neurological diseases. Excitotoxicity is triggered by excess synaptic Glutamate (Glu), causing hyperactivation of postsynaptic Glu receptors (GluRs), and a toxic influx of calcium that leads to necrotic cell death. Surprisingly, Glu signaling also activates neuroprotective pathways, including the activation of the transcription factor CREB. Though hundreds of mechanisms have been described to activate CREB in many cell types, the mechanism by which CREB is activated in excitotoxicity to provide neuroprotection remains unclear. We aim to discover the specific mechanism of CREB activation that confers neuroprotection in excitotoxic necrosis. Canonical models of CREB activation involve its phosphorylation, while an alternative model in neuroprotection proposes the activation of CREB’s co-factor CRTC. To test this, we use the genetic model system of the nematode C. *elegans* as they provide a simplified and conserved version of many signaling cascades, including Glu-signaling. By combining Glu-transporter knockout with a sensitized genetic background we developed an excitotoxicity model in the nematode. We have found that both CREB/*crh-1* and CRTC have an evolutionary conserved role in excitotoxic neuroprotection. We now set out to compare the subcellular localization of CRTC in un-stimulated and excitotoxic conditions by imaging fluorescently labeled transgenic CRTC expressed in strains with/without excitotoxicity. We hypothesized that in un-stimulated conditions CRTC is cytoplasmic, while in excitotoxic conditions it translocates into the nucleus. Establishing the specific mechanism of CREB activation and gene transcription in neuroprotection may help us discover new therapeutic targets for treatment of neurodegenerative diseases.

# GROVE SCHOOL OF ENGINEERING

## Electrochemical Study of Composite Sulfur-Carbon Black Cathodes in Rechargeable Aluminum Batteries

### Peter Fields and Robert Messinger  Department of Chemical Engineering

The increase in demand for low-cost, environmentally friendly, and efficient energy storage has motivated the research of new rechargeable battery technologies. Aluminum is a good alternative to lithium as an anode material in batteries because of its high abundance in the Earth’s crust (7.740 % by weight as compared to lithium’s

0.002 %) and its higher volumetric capacity (8046 mAh/mL to lithium’s 2262 mAh/mL). Sulfur has undergone much investigation as an alternative cathode material, with much research in recent years devoted to lithium-sulfur, sodium-sulfur, and magnesium- sulfur chemistries. Sulfur has a high theoretical capacity of 1672 mAh/g and is also abundant and low-cost. If achieved, an aluminum-sulfur battery could meet current energy storage needs. However, the proposed battery chemistry suffers from short cycle life, unreliable voltage plateaus, poor reversibility, and quick decay of discharge capacity. These scientific challenges are not well understood, as only three scientific articles on the matter have been published. Here, we reproduced these model battery systems from literature in order to conduct fundamental electrochemical analyses. Composite cathodes of ball-milled carbon black and sulfur were fabricated and tested in a Swagelok cell with an aluminum. The cells were galvanostatically cycled and data were collected showing the relationship between specific discharge capacity and voltage. Discharge voltage plateaus consistently occurred between 0.4-0.6V, below the earlier reported 1.0 V. Control experiments were performed to understand the discharge capacity contribution of theadditive material (carbon black). Results showed that only 70 mAh/g of capacity came from the carbon black and therefore could not account for incongruities in the experimentally determined specific discharge capacities of the sulfur in different cells.

## Adsorption of Bovine Serum Albumin to a Liquid-Crystal Interface

### Ariella Himelstein and Raymond Tu Department of Chemical Engineering

The purpose of this study is to investigate liquid crystal response to protein adsorption. More specifically, we aim to develop a biosensor for the quantitative analysis of the dynamics of biomolecular absorption to a fluid-fluid interface. Bovine Serum Albumin (BSA) is adsorbed from the solution phase to the water-liquid crystal interface. We examined the dynamics of the adsorption process under a polarized microscope, measuring the rate of the phase change from the planar to homeotropic orientation of the liquid crystal. The BSA first adsorbed onto the liquid crystalline. Around the sites where the BSA is adsorbed, the liquid crystalline aligned with the BSA, around the sites where there is no adsorption the liquid crystalline shifted away from the sites of adsorption. Moreover, we aim to examine the reproducibility of our liquid crystal sensor as a proof-of-concept for its application as a bio-sensor for non-specific protein adsorption.

## Phase Separation in Proteolipid Bead Systems

### Huda Yousuf1,2; William Houlihan2; Lane M. Gilchrist2 Department of Chemical Engineering

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The lipid bilayer is a key component of the plasma membrane which allows it to define boundaries within the cell and regulate transport. It was previously believed that the plasma membrane consists of a homogenous lipid bilayer with membrane proteins randomly dispersed throughout. Recent research supports the existence of lipid raft domains within the plasma membrane. According to the lipid raft theory, areas rich in sphingolipids and cholesterol can form lipid raft domains which form the liquid ordered phase of the plasma membrane. The raft domains are believed to have a significant role in protein partitioning.

It is difficult to observe phase separation within live cells due to their nanoscopic size and fleeting existence, only lasting for nanoseconds at a time. Thus, other biomimetic systems have been used to observe phase separation and protein partitioning. In our experiment, we utilize supported lipid bilayers using silica beads with lipid composition of 2:2:1 Sphingomyelin(SM): DOPC (1,2- dioleoyl-*sn*-glycero-3- phosphocoline): Cholesterol, along with fluorescent dyes to observe lipid raft domains. We were able to successfully detect phase separation within three of our lipid bilayer systems: 2:2:1 SM: DOPC: Cholesterol, 2:2:1 with 10% brain polar lipid extract (BPLE), 2:2:1 with 40% BPLE. The lowest amount of ordered phase coverage, at 64.7%, of phase separation, was observed in the 2:2:1 SM: DOPC: Chol with 40% added BPLE. While the other two lipid samples averaged to 74% ordered phase coverage.