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UNDERGRADUATE RESEARCH ABSTRACTS.

A publication of Yeshiva College and Stern College for Women; Volume IV : 2010-2011

Dedication

In tribute to our friends and mentors,
Eli Steinberger z'l
(USRP Co-President 2006-07)
and
Donny Ladell z'l
(USRP Co-President 2005-06),
who we miss dearly.

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Preface

It is with pleasure that we present the 2011 issue of Yeshiva University's Undergraduate Research Abstracts. This undertaking by the men and women of Yeshiva College and Stern College for Women represents both a unification of interests in scientific research and a dissemination of knowledge to the entire Yeshiva University.

The Science Departments at both YC and SCW encourage and direct students to broaden their educations and experiences beyond the classroom by taking part in scientific research. The number of abstracts presented in this journal attest to the numerous men and women who do, indeed, actively seek opportunities to engage in research, both on campus and at national and international institutions. Though the research projects described herein cover a broad spectrum of topics, the common denominator in this impressive collection is the commitment of dozens of students to the sciences. I have been fortunate to witness first-hand the passion and dedication of our students, as well as the way their minds develop as a result of their research experiences.

Their research abstracts testify to the quality of their efforts and contributions to the research project.

Many undergraduates begin their careers under the guidance of accomplished scientists; research internships may begin the process towards their career goals. Thus, the work of our undergraduates presented in this journal may, in fact, contain the seeds of ideas that will one day change our world.

We commend these students for their achievements and perseverance, and hope they continue to pursue their goals and meet future challenges with success.

Alyssa Schuck, Ph.D.
Clinical Assistant Professor of Biology
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Introduction

In the Spring of 2011, Yeshiva University reached a new milestone in its pursuit of the scientific endeavor. Back in the 1960's and 70's, Yeshiva University's Belfer Graduate School of Science was a major center of scientific research in the United States. It boasted such luminaries as Freemon Dyson and Roger Penrose, and it was at Belfer that Leonard Susskind co-discovered String Theory. Since Belfer was closed in the late 1970's, Yeshiva University has made considerable contributions to the scientific corpus, despite lacking the advantages of a dedicated graduate program. However, this year, as undergraduate researchers at Yeshiva University, we were thrilled to witness the beginning of a graduate program in Mathematics at Yeshiva University. With the hiring of top new researchers in all fields of science, we hope that this is only the beginning of a new era of scientific discovery at Yeshiva University.

The student body also directs its efforts towards fostering an environment of scientific achievement. Undergraduate Student Research Presentations (USRP) is one of the premier science clubs at Yeshiva University. Together with Stern College's Student Undergraduate Research Group Experience (SURGE), two highly active chemistry clubs, a new cross-campus Computer Science Club, and the Math, Physics, Biology and Neuroscience clubs, USRP tries to promote constant engagement with science and scientific research at Yeshiva University. Recent events included an intercampus poster session, renowned lecturers, and frequent student-led research presentations.
In that light, in co-operation with the editors from Stern College's Women in Science and the Stern College Observer, we bring you the 2011 edition of Undergraduate Research Abstracts, which we view as a small measure of our success. It contains abstracts of student research in Psychology, Physics, Biology, Mathematics, Chemistry and Computer Science. Students at Yeshiva University work with both professors on-campus and with professors at other institutions in order to develop themselves as thoughtful participants in the exciting world of scientific research. These abstracts manifest their time and effort, and we would like to thank them for contributing to this publication.

We would also like to thank our faculty advisors, Dr. Neer Asherie and Dr. Harvey Babich, who helped make this publication possible

We hope you enjoy,

Daniel Alweis,
Faygel Beren,
Meira Lerner,
Raphael Mamane,
Robert Rand,
Rivkah Rogawski,
Menachem Spira

Chemistry

Biology

Mathematics/ Computer Science

Physics

Psychology

Computational Biochemistry

HYDROGEN BONDING IN SULFATED TYROSINE RESIDUES

by

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Tyrosine-*O*-sulfation, the addition of a sulfate (SO_4^{2-}) group to a tyrosine residue, is one common post-translational protein modification. Sulfation plays an important role in leukocyte adhesion during the inflammatory response, chemokine receptor binding and related HIV and malaria infections, and blood clot formation. Functional differences between sulfated and non-sulfated tyrosine are related to sulfate's propensity for hydrogen bonding with positively charged basic amino acids. Using implicit solvent molecular mechanics studies of residue pairs, we sought to characterize this hydrogen bonding capability of sulfated tyrosine, with regard to (1) the strength of the hydrogen bond of sulfation, as determined by the distance that resulted in the lowest energy for the system, (2) the effect of different hydrogen bond donors (basic amino acids lysine or arginine), (3) the effect of orientation (linear or coplanar geometry between hydrogen bond donor and acceptor). The widely studied post-translational modification of phosphorylation was used as a control.

Calculations of electrostatic and van der Waals energies showed that hydrogen bonding between sulfated tyrosine and basic amino acids is much less favorable than hydrogen bonding involving phosphorylated tyrosine. While phosphorylated tyrosine achieves favorable hydrogen bonding, manifested in a lower energy for the interacting residues than for the isolated residues, hydrogen bonding involving sulfated tyrosine is more favorable when stabilized by a water molecule and not direct ion-pair interaction. While phosphorylated tyrosine interacted most favorably with arginine in a coplanar geometry, sulfated tyrosine interacted more favorably with lysine in a linear geometry. The distance between the ions which resulted in the most favorable direct interactions was similar for both phosphorylated and sulfated tyrosine, although phosphorylated tyrosine consistently had more favorable interactions both directly and with water-mediated stabilization. Future work will expand these calculations to include protonated phosphorylated tyrosine (charge -1), to determine whether difference in charge between sulfated (-1) and phosphorylated (-2) tyrosine is responsible for the differing hydrogen bonding capability for these modifications.

Research conducted as part of a senior honors thesis at Stern College for Women, advised by Dr. Chaya K. Rapp.

Student Researcher

Hadassa Klerman is a senior at Stern College for Women, majoring in biochemistry and looking forward to medical school next year. She is interested in the applications of mathematics and modeling to areas of scientific research ranging from circadian rhythms to effects of protein modifications. When not in the chemistry lab, she plays multiple musical instruments and is a member of SCW's Chamber Music Ensemble.

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Biophysical Chemistry

THE INTERACTION OF LYSOPHOSPHATIDIC ACID WITH MODEL MEMBRANES

by

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Lysophosphatidic acid (LPA) is a bioactive phospholipid produced intracellularly and extracellularly by a variety of enzymes. Through its interaction with G-protein coupled receptors (GPCRs), LPA is able to cause a range of downstream physiological reactions. LPA is thereby implicated as a signaling mediator in a plethora of cellular processes including nociception, inflammation, chemotaxis, cell development, and cancer growth. However, in addition to its role as a ligand for GPCRs, LPA may be able to affect the physical properties of bilayer membranes due to its amphipathic structure. This could in turn affect the physical properties of nearby lipid-lipid and lipid-protein interactions, including GPCRs, which reside in highly ordered lipid domains.

Although putatively significant, the thermodynamic and mechanistic parameters of LPA's interaction with bilayer membranes remains unknown. Using isothermal titration calorimetry (ITC), we explored the interaction of LPA with model membranes constructed of the phospholipids POPC and DPPC. These experiments indicated that LPA does indeed interact endothermically with bilayer membranes. This suggests that the interaction is driven by entropic rather than enthalpic forces. Additionally, we observed that the LPA/membrane binding exhibited a breakpoint at a ratio of 0.5, implying that the LPA molecules intercalate primarily into the outer leaflet of the membrane. These experiments clearly indicate an interaction of LPA with membranes that may have implications for its role as a regulatory molecule in cellular signaling pathways.

Research conducted as part of a senior honors thesis at Stern College, advised by Dr. Evan Mintzer.

Student Researcher

Rivkah Rogawski is a senior at Stern College majoring in chemistry. Rivkah is looking forward to a lifetime of increasing entropy as she pursues a career in chemistry, and next year she will be starting graduate school as an IBio fellow at Columbia University's chemistry department. In her spare time, she enjoys hiking, reading and cooking up mysterious chemical concoctions in her personal home laboratory

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Biochemistry

DESIGNING AUTOMATED HIGH-THROUGHPUT FOOTPRINTING FOR PERSONALIZED MEDICINE

by

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Current trends in medical therapeutics pertain to the design and development of individualized drugs. One class of such drugs is designed to target specific sequences on an individual's DNA (and/or RNA) and thereby modify gene expression. A present bottleneck in the development of such drugs is the lack of an efficient method of determining DNA secondary structure. To do so, we must expand our technological methods to be able to assess the static and dynamic topographical surface of many individual DNA fragments in a facile manner, which will allow for the wide-scale, efficacious implementation of individualized medicine. A technological method which provides the key is structural footprinting, a method which employs chemical probes to assess the solvent-exposed surface of folded complexes. Reagents of small size and high reactivity, such as hydroxyl radicals, which cleave the solvent-exposed backbone of the nucleotide complex of interest with single nucleotide resolution, are ideal probes for structural footprinting techniques. Time-resolved hydroxyl radical footprinting can be used to study the dynamics of nucleic acid biopolymers by detecting the cleavage intensity of individual nucleotides as a function of time, providing insight into intermediates in the folding pathways of RNA assembly or into molecular recognition events, as well as providing more information with which to design an individually tailored drug. To quickly obtain large amounts of footprinting data, the footprinting must be conducted in an automated high-throughput manner.

We therefore designed an automated high-throughput footprinting process. We utilized a reusable, solid state hydroxyl radical source, pyrite (FeS2), in which the iron in combination with hydrogen peroxide reacts to form hydroxyl radicals via the oxidation of iron (II). Our collaborator developed a pyrite microfluidic device through which the nucleotide fragment of interest and hydrogen peroxide are passed, exposing the sequence to hydroxide radicals, which cleave the sequence. We also performed the footprinting experiment using the standard liquid-iron Fenton chemistry to ensure that similar results were obtained.

The 298 base pair test DNA sequence we used was first amplified by Polymerase Chain Reaction (PCR) for 35 cycles at 60°C. A deoxyribonucleotide triphosphate (dNTP) mix of 0.4mM (consisting of an equal portion of each of the dNTPs) was used. The target DNA was then footprinted by either liquid-iron produced hydroxyl radicals or by pyrite produced radicals. The fluorophore Cy5 was attached to the DNA either before ("pre-cleavage labeled DNA") or after ("post-cleavage labeled DNA") cleavage for optimization. The fragments, detected by a capillary electrophoresis (CE) system, were assigned cleavage intensity peaks plotting cleavage intensity for each nucleotide using CAFA (Capillary Automated Footprinting Analysis) software. Detecting fluorescence using a CE system is a step towards automating the footprinting process when compared to the current method of detecting a radioactive label by electrophoresis through a polyacrylamide gel. As a negative control, a sample of full length DNA, not subject to hydroxyl radical cleavage was prepared. This was subtracted from the footprinting results. Similar results were obtained whether the fluorophore label was attached before or after cleavage, and whether the hydroxyl radicals used for footprinting were produced using the standard Fenton reaction or pyrite.

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Epigenomics

EPIGENOMIC REGULATION OF THE PIG-S GENE IN PROSTATE CANCER

by

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DNA methylation is an epigenomic phenomenon in which a methyl group is added to the 5 position of a cytosine pyrimidine ring in a sequence of DNA by way of either maintenance or de novo methyltransferases. The methylated DNA molecule becomes physically condensed, resulting in gene silencing and a subsequent loss of protein expression within the affected cell. Many membrane proteins are anchored to the plasma membrane via glycosylphosphatidylinositol (GPI). The GPI transamidase (GPIT) complex mediates GPI anchoring in the ER, by replacing a protein's C-terminal GPI attachment signal peptide with a pre-assembled GPI. The GPIT is a complex containing five subunits; PIG-T, GPAA1, GPI8, PIG-S and PIG-U. Each subunit is critical for maintaining the complex and is essential for the transfer of GPI to proteins. Recent studies have discovered that in many cancer types, but most clearly seen in prostate cancers, there is a progressive loss of the PIG-S polypeptide, and research has been conducted at the protein, RNA, and genomic levels to determine the cause of this loss with no conclusive results.

This study aimed to observe the relative methylation levels of the PIG-S gene in early- and late-stage prostate cancers, respectively, and to determine whether or not the loss of the PIG-S polypeptide can be attributed to epigenomic gene silencing. If our hypothesis was correct, the late-stage cancer samples would show a markedly higher amount of methylation than the early-stage samples. DNA was extracted from four cancer cells lines: LnCap and 22Rv1, early stage prostate carcinomas; and PC3 and DU145, late-stage prostate carcinomas. The extracted DNA was bisulfite converted and a bisulfite sequencing PCR was run to amplify the fragment of interest. A 1.5% agarose gel was used to determine if amplification was achieved. The bands were then extracted, purified, and sent for sequencing to determine their methylation patterns. Our results showed a low level of DNA methylation across all four samples, thus ruling out epigenomic silencing in the region that was amplified, as the cause for the loss of the PIG-S subunit in cancer cells lines. Future studies will re-examine other areas of the promoter region of the PIG-S gene, as well as the genes of the other four GPI transamidase subunits, for epigenomic regulation; more extensive studies will also be conducted at the RNA and microRNA levels.

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Student Researcher

Helen Unger is a sophomore at Yeshiva University majoring in Biology with a concentration in cellular and molecular biology. She hopes to pursue graduate studies in the biological sciences, and is particularly interested in genetics and microbiology.

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Neuroscience

DETERMINING THE OPTIMUM PROLIFERATION AND DIFFERENTIATION MEDIA FOR EVENTUAL CULTURE OF POST-MITOTIC MOBILE NEURONS

by

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Every 41 minutes another person in the U.S. sustains a spinal cord injury. These injuries cause primary and secondary damage to spinal cord neurons and can result in paralysis or death. Current and past attempted methods of treatment involve injecting neural stem cells through lumbar puncture or injecting mature neurons directly onto injured tissue. The first method can be compromised by tumor growth due to excessive proliferation of injected cells; the second is technically challenging and can cause further damage to the spinal cord and to the transplanted cells. Additionally, injecting mature neurons through lumbar puncture is ineffective, as these cells cannot home in on the wounded are as stem cells do. In order to achieve a more effective and safer method of treatment, we attempted to culture neurons that were post-mitotic yet still mobile. Ideally, these new neurons could be injected through lumbar puncture and home in on the injury site without the danger of potentially cancerous proliferation.

The goal of this study was to determine the optimum proliferation and differentiation media for culture of post-mitotic mobile neurons. The experiment was conducted with GE6 cells, a neural stem cell line known to produce GABA-ergic neurons. The cells were thawed in DFB media with 10 ng of EGF and 10 ng of FGF and were given these two growth factors every other day. DFB is a supportive media that can be used for either proliferation or differentiation. To study proliferation, the cells were grown in DFB media that had either 1 ng EGF or 0 ng EGF. After 2 days the media was switched to DFB/NDM 1:1. NDM is a media that promotes differentiation. The cells underwent a one half media change every 2 days to gradually decrease the amount of DFB media present. The cells were then pulled and fixed at appropriate time points. Antibodies used to determine the maturity of the cells and the type of cell included Ki67, TuJ1, Nestin, DCX, Galc, GAD 65/67, and GFAP. The cells were then photographed using a Zeiss fluorescent microscope and manually counted.

The results of the study were that the presence of even low levels of EGF in proliferation media prolongs the state of proliferation, even after the media is changed and differentiation is expected to begin. Ki67 (which marks proliferating cells) levels were higher and TuJ1 (which marks neurons) levels were lower in 7 day differentiated cells that had experienced EGF than those that had not. This supports the theory that EGF inhibits differentiation and keeps stem cells immature. When stained with Nestin and DCX (another marker for neurons), however, the opposite trend appeared. A possible cause is the early appearance and subsequent down-regulation of DCX in the cells with 0 ng EGF, which would result in a transient stain.

Future studies include a replication of these experiments and a repeat of the Nestin/DCX staining using cells in a wider range of ages, which would investigate the appearance and fading of DCX and provide implications for the above theory.

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Student Researcher

Ashley Ansel is a junior at Stern College for Women majoring in Biology. In her free time, Ashley enjoys playing volleyball and has played for the YU Maccabees for two years. Ashley is also an executive board member of the Genetics Club and hopes to pursue a career in Genetic Counseling.

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Neuroscience

FRAGILE X MENTAL RETARDATION PROTEIN AND ITS EFFECT ON SYNAPTIC PLASTICITY

by

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Synaptic plasticity, the intricate ability of neurons to interact within the brain, forms the basis of memory and learning. Connections between dendrites are formed by dynamic interactions between numerous small protrusions packed along the length of the dendrites, called dendritic spines. These spines, often less than 1 micron in diameter, undergo significant morphological changes during stimulation, an effect shown to be critical in various aspects of long-term plasticity (Segal, 2005).

When changes occur within the neural network that disrupt its ability to properly form synapses, profound cognitive and behavioral features are manifest. Fragile X syndrome, the most common genetically inherited form of cognitive deficiency, results from the deactivation of a single gene on the X chromosome. Deactivation of this gene leads to the absence of the Fragile X mental retardation protein (FMRP) within the system.

FMRP is an mRNA binding protein thought to be critical in the transport and translation of selected mRNAs. In normal cells, FMRP is localized in dendrites and spines and is hypothesized to be critical in protein regulation and spine development. Analysis of the Fragile X neuroanatomical phenotype shows dendrites with altered dendritic spine morphology, underscoring the importance of FMRP in spine development and maturation (Bassell, et al., 2008).

Our goal is to better understand the morphological changes that occur within neurons in the Fragile X phenotype. By transfecting primary hippocampal cultures with fluorescently labeled mutant FMRP, we are able to analyze the localization of FMRP within the neurons. Furthermore, through using siRNA to block FMRP expression, we can gain a greater insight into the morphological changes occurring in Fragile X cells. With the aid of a high-resolution confocal laser-scanning microscope, we were able to image time-lapse series in an attempt to follow the movement of FMRP within the cell during excitation.

Using confocal laser-scanning microscopy, we found that FMRP localizes in the dendritic spines of neurons (see figure 1). This finding sheds further light on the role that FMRP plays in the neuron. Since FMRP is an mRNA binding protein which regulates the translation of mRNA transcripts, its localization in the dendritic spines allows it to regulate synaptic plasticity – i.e., the ability of neurons to dynamically interact within the brain.

Furthermore, we found that mutant FMRP, FMRP which had lost its mRNA binding region, spread diffusely throughout the neuron (figure 2) instead of forming small clumps (figure 3). This finding supports the fact that FMRP's main role in the neuron is to shuttle mRNA transcripts throughout the neuron. As such, the normal FMRP clings to its mRNA transcripts, thus forming a complex of FMRP-mRNA, while the mutant FMRP is unable to attach to any mRNA transcripts, thus remaining diffuse throughout the cell.

By better understanding the molecular processes occurring in the Fragile X genotype and the resultant morphological impact on the neuronal network, it is possible to both gain insight into synaptic plasticity as a whole and into potential therapies for future individuals affected by the Fragile X syndrome.

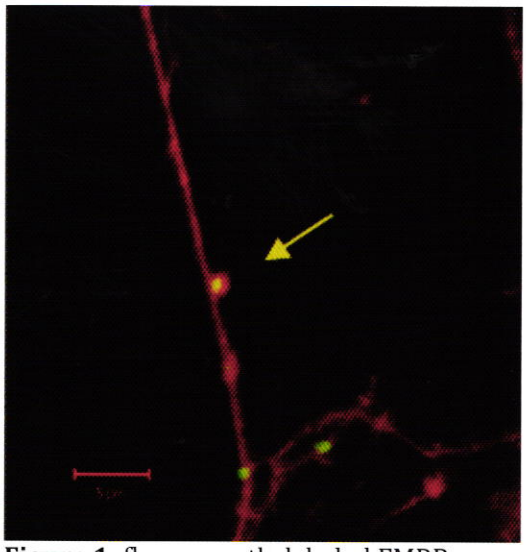

Figure 1: fluorescently labeled FMRP (yellow dot) localized in the dendritic spine.

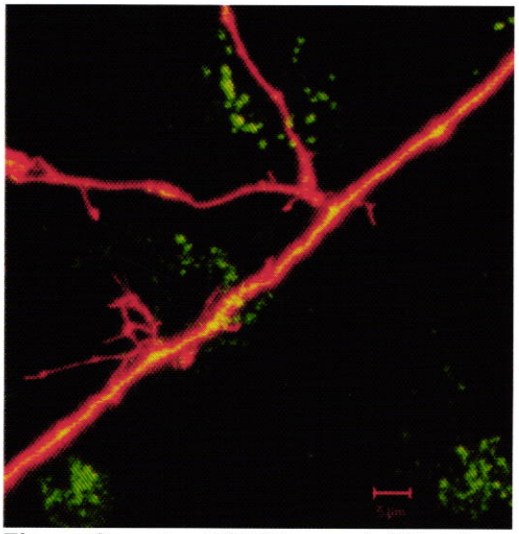

Figure 2: mutant FMRP spread diffusely through dendrite.

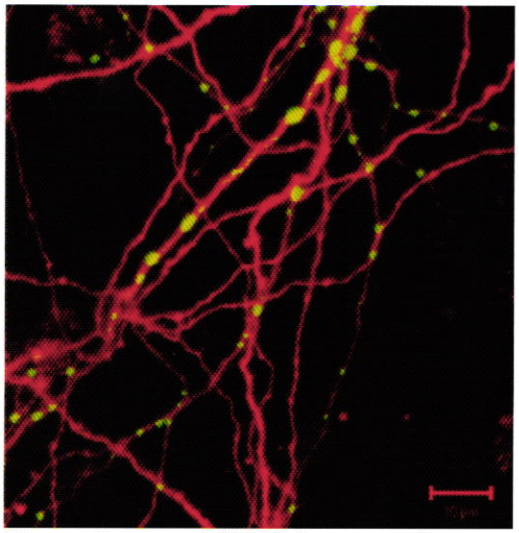

Figure 3: normal FMRP forms small clumps inside the dendrites.

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Student Researcher:

Adam Berman is a graduating senior majoring in Psychology who will be applying to medical school this summer. Besides for his fascination with the brain and the human body, Adam loves to ski, hike, and relax with his wonderful friends. He wants to take this opportunity to thank Yeshiva University and its community for a wonderful and stimulating four years.

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Immunology

AID AND GADD45A: ARE THEY INVOLVED IN ACTIVE DNA DEMETHYLATION OF THE 3'RR AND CLASS SWITCH RECOMBINATION?

by

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The production of antibodies, proteins with two heavy (H) chains and two light chains, helps the body fight the large repertoire of invading pathogens. A shift in expression from the IgM antibody isotype to other classes of antibodies occurs via H chain gene DNA rearrangements in a process termed class switch recombination (CSR). CSR is regulated by a 3' regulatory region (3'RR), which acts at long distances on the H chain coding regions to promote H chain germline transcription required prior to CSR. The Birshtein lab has shown that the 3' RR undergoes progressive DNA demethylation during CSR, including an early stage of replication-independent active demethylation. A question we are addressing is whether active DNA demethylation is critical for CSR. Two proteins implicated in active DNA demethylation are activation-induced cytidine deaminase (AID), a B cell-specific trans-acting protein critical for CSR, and Gadd45a, a protein involved in genomic stress.

My first project determined whether AID was involved in demethylation of the 3'RR region. Analysis, using AID knockout mice, showed no significant difference in demethylation between wild-type (WT) and AID knockout (KO) mice. My second project involved Gadd45a. Although it was previously shown that B-cells from Gadd45a KO mice had reduced active DNA demethylation in their 3' RR during switching, no defects in CSR were observed in these mice. To examine if splenic B-cells contained potential compensators that would allow CSR to occur in the presence of reduced Gadd45a expression and reduced DNA demethylation, we performed a lentivirus knockdown of Gadd45a in CH12 cell lines. Using FACS analysis, we found no significant difference in switching between the control shRNA and Gadd45a knockdown.

Therefore, we concluded that (1) there is no connection between AID and active demethylation, and (2) there is no direct link between Gadd45a, demethylation and CSR.

Student Researcher

Tsipora Huisman is from the Netherlands and is a senior in Stern College, majoring in Biology with a concentration in Molecular and Cellular Biology. Tsipora is the co-president of the Pre-Med club and spent last summer in the ROTH program at Einstein Medical School doing research in Cell Biology. Tsipora is an active volunteer at the MJHS hospice and loves to play tennis and the piano in her free time.

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Immunology

CORRELATION BETWEEN SERUM AND PLASMA ANTIBODIES TO MYCOBACTERIAL ANTIGENS

by

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Many cases of active tuberculosis (TB) are challenging to diagnose, especially those that occur in HIV+ individuals. In these cases, serodiagnosis in the form of detection of antibodies to immunodominant antigens of Mycobacterium tuberculosis (MTB) could be an ideal adjunct test to diagnose TB earlier. Traditionally, serum, which does not contain fibrinogen and clotting factors (unlike plasma), is used to test for antibody responses to MTB. However, it would be beneficial to be able to utilize serum or plasma samples interchangeably. However, to our knowledge no studies have compared the antibody responses to mycobacterial or other antigens detected in serum versus plasma.

To determine whether levels of serum and plasma antibodies correlate, we simultaneously obtained serum and plasma samples from TB and non-TB patients. We tested the samples by ELISA for IgG and IgA antibodies to two immunodominant proteins and a polysaccharide antigen of MTB. Results were correlated using the Spearman rank test.

A very strong and highly statistically significant correlation (average $r = 0.924$; $p<0.0001$ for all data sets) was found between serum and plasma antibody responses for both IgG and IgA to all 3 mycobacterial antigens tested. In subgroup analysis for TB+/TB- and HIV+/HIV- samples, the correlation remained strong and statistically significant. We therefore concluded that serum and plasma samples can be used interchangeably to test for antibody responses to mycobacterial antigens, even in the same assay.

Acknowledgments

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The full report appeared in Journal for Clinical and Vaccine Immunology. 2011 Jan; 18(1):173-5.

Student Researcher

Michael Siev hails from North Miami Beach, Fl. He studied at Yeshivat Har Etzion and completed his BA in Biology and Music from YC this January. He enjoys music, working out, XKCD, and red meat. He also loves his wife.

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Speech Pathology and Physiology

INCIDENCE OF DYSPHONIA AND DYSPHAGIA FOLLOWING ANTERIOR CERVICAL SPINE SURGERY

by

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The anterior approach is the preferred, more common technique to cervical spine surgery. It allows the surgeon to address discs, bony structures and anterior lesions before directly impinging on the spinal cord. There are, however, sequellae that are relatively common complications. Specifically, dysphonia and dysphagia present themselves as significant side effects in this type of surgical procedure. Dysphonia describes a group of symptoms affecting vocal tone, effort, and quality, while dysphagia describes a related group of symptoms dealing with eating and swallowing. The reported incidence of these symptoms ranges from over 50% (Bazaz, 2002) to less than 10% (Fountas, 2007). However, anecdotal conversations with surgical and anesthesiology teams at North Shore University Hospital/Long Island Jewish suggest a lower rate of occurrence. This project aims to identify, using chart review, the identified incidence of complaints of hoarseness and swallowing difficulties in a two year period at the NSUH/LIJ system.

The working hypothesis was that the documented incidence would be close to or less than a 10% rate. Data was collected by recording the patients' age, gender, history of previous cervical spine surgery, pre-existing voice or swallowing conditons, and initial complaints, along with each case's surgical approach, number of levels, number of grafts, type of graft, duration of surgery, distractors/intubation-extubation time, and recovery room stay/type of NIOM. The data was recorded and the incidence of voice disorders and swallowing disorders calculated. These data were compared to see if, in fact, NSUH enjoys a lower incidence of these sequella. The next stage of the study looked more closely at the demographics of the patients and procedures collected. Post-facto analyses then helped to identify if any of these variables are statistically contributory to the incidence. The published data will identify these factors as possibly related, though not universally supported. This information will help to determine if NSUH has any of the factors that relate to these sequella.

The clinical impression at the North Shore University Hospital implied a much lower incidence of sequellae than published elsewhere. The chart review culled data from consecutive anterior cervical spine charts from 2008-2009. The data from the first 93 subjects are reported with an overall incidence of 5.4% dysphonia and 14% dysphagia. A multiple surgical level bias was noted as similar to literature trends. Other factors such as gender, anesthesia grade, and surgical technique/handedness were not remarkable. Of those variables identified in the study, the more significant factors were age and multiple surgical levels, rather than issues that reflect surgical or anesthetic techniques.

Student Researcher

Davina Simhaee is a junior at Stern College, majoring in Speech Pathology and Audiology. She aspires to be a Speech Language Pathologist who provides clinical care while simultaneously engages in research. She ultimately plans to undertake and supervise her own rehabilitation center. During her spare time, Davina enjoys playing the piano, practicing yoga, and spending time with her family and friends.

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Nephrology

PAR1 LOCALIZATION DURING EMBRYONIC KIDNEY DEVELOPMENT

by

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The glomerulus is the filtering unit of the kidney consisting of capillary loops surrounded by epithelial cells called podocytes, which are connected by slit diaphragms. During podocyte development, columnar epithelial cells of the S-shape body evolve into highly structured and polarized cells. The arborized structure of the podocyte is required to maintain the integrity of glomerular filter and is disrupted in proteinuric kidney diseases like focal glomerulosclerosis (FSGS).
Partitioning-defective proteins (Par) play a role in establishing cell polarity in columnar epithelial cells and neurons by asymmetric localization of Par1 and the Par3/Par6/aPKC complex to distinct cell membrane domains. It has been shown that the Par3 complex localizes to the podocyte slit diaphragm, and that the complex is required for normal podocyte structure.
Our lab has identified the expression of Par1a/b kinases in podocytes and in developing nephrons. Based on our research, we hypothesized that Par1a/b contributes to podocyte differentiation. Hence, the objective of our current research was to examine the expression of Par1a/b during embryonic kidney development and in adult podocytes.

Immunogold labeling of Par1a in kidneys examined by electron microscopy allowed us to localize Par1a predominantly to the podocyte cell body and foot process cytoplasm. Within the foot process, the majority of Par1a localized to apical or basal aspects of the foot process, rather than at the slit diaphragm. Consistent with this, Par1a in adult glomeruli co-localized with the apical podocyte marker podocalyxin on confocal immunofluorescence. Next, embryonic rat kidney tissue was co-stained for Par1a/b and for WT-1 or Pax-2, which demarcate the metanephric mesenchyme (MM) and developing S-shape nephrons. Par1a/1b were expressed in the MM and in S-shape nephrons. Last, quantification of Par1a/1b expression was examined using western blotting, demonstrating increased expression in embryonic day 15 kidneys, at which time glomeruli begin to form.

Together, these data suggest that Par1a/1b may play a role in podocyte differentiation. Further studies are necessary to define Par1a/b function in the developing and mature kidney.

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Acknowledgements
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Student Researcher
Orli Haken is currently a senior at Stern College majoring in Biochemistry. She plans to continue her education in the medical field, where she is interested in pursuing clinical research in addition to a career as a physician. Orli has a passion for ice skating and can be found on the ice rink at Bryant Park throughout the winter.
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Ophthalmology

EFFECT OF OXIDATIVE STRESS ON RETINAL GANGLION CELLS: A MODEL FOR GLAUCOMA

by

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Glaucoma is the second leading cause of blindness worldwide. In order to mirror the homeostatic conditions during progressive loss of blood flow to the optic nerve that is often associated with glaucoma, we studied the ramifications of oxygen and glucose deprivation (OGD) on retinal ganglion cells. There were two parts to our study. First, we wanted to determine whether OGD treatment resulted in primarily apoptosis, a form of preprogrammed cell death, or necrosis. Second, we wanted to test the hypothesis that Ca2+ entry through Ca2+-permeable AMPA receptors (AMPARs) might exacerbate the effect of OGD and increase the frequency of necrosis/apoptosis.

Accordingly, we treated cultured retinal neurons overnight with an AMPA receptor antagonist, a treatment which has previously been shown to increase the percentage of Ca2+-permeable to Ca2+-impermeable AMPARs. Control and treated cells were exposed to OGD treatment for 20 minutes and then either processed immediately to measure necrosis using standard techniques, or after 24 hours to measure apoptosis. Significant apoptosis was not detected in neurons by the TUNEL assay, but there was a two-fold increase in fragmented DNA in OGD samples found outside of neurons, thereby suggesting that OGD has adverse effects on neurons. Further experiments are being conducted to ascertain if these adverse effects are caused by fast acting necrosis.

Student Researcher

Daniel is a fourth year senior from Hollywood, FL majoring in Biology and minoring in History.

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Developmental and Molecular Biology

DETERMINATION OF BUCKY BALL PATHWAY AND BINDING DOMAIN VIA ITS PROTEIN INTERACTORS

by

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The establishment of oocyte polarity along the animal-vegetal axis is a critical process for establishing the germline though localization of the germ plasm in vertebrates. The Balbiani body, an evolutionarily conserved aggregate of organelles, RNAs and proteins, is the first identified sign of asymmetry in the oocyte. Bucky ball, a protein which localizes to the Balbiani body and has no known functional domains, is essential for the assembly of the Balbiani body, the localization of vegetal RNAs, and the eventual polarization of the oocyte, as seen through the mutant phenotype.

The pathway through which Bucky ball mediates this process is heretofore unknown. A Yeast-two-hybrid screen was performed to identify possible protein interactors and their binding domains on Bucky ball. A cDNA library obtained from human ovarian tissue was screened for interaction. If the tested protein positively interacted with Bucky ball a reporter gene was transcribed. Multiple, unique interactor proteins, many of them implicated in infertility, were identified as preliminary proteins that interact with Bucky ball. This interaction will be verified in the future via EMSA and co-immunoprecipitation studies. Additionally, truncated versions of Bucky ball were utilized to identify possible binding domains on Bucky ball for the specific proteins with which it interacts.

Student Researcher

Danielle Lent is a senior at Stern College. She is a Biochemistry major and an English and Philosophy minor. She aspires to be a physician with a pediatric concentration. Danielle hopes to complete a triathlon and be on Jeopardy!

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Developmental and Molecular Biology

AUTOPHAGY IN THE GROWTH OF PRIMARY CILIA

by

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Mouse embryo fibroblasts (MEFs) grow primary cilia upon serum starvation for 6-48 h. At approximately the same time that primary cilia are forming during cell-starvation, these cells undergo the process of autophagy. Autophagy is a catabolic pathway that results in the degradation of cytosolic components inside lysosomes. The fact that autophagy and primary cilia formation are occurring in the cell at the same time suggests a possible functional relationship.

Two forms of autophagy—macroautophagy and chaperone mediated autophagy (CMA)—are induced by starvation with kinetics similar to the induction of primary cilia. To test whether ciliary growth was affected by loss of macroautophagy, we used pharmacological modulators of macroautophagy in cells from a mouse knocked out for an essential component of this autophagic pathway. Despite differing levels of functioning macroautophagy processes, all cell lines grew primary cilia; these results suggest that macroautophagy is not required for cilia formation.

In contrast to the above experiment, we found that acute blockage of macroautophagy by 3-methyladenine resulted in a marked increase in the number of primary cilia even in cells grown in nutrient-rich media. Cells with chronic blockage of macroautophagy showed a similar trend, although differences with wild-type were less pronounced. These results illustrate the importance of macroautophagy in modulating the energetic cellular balance. Even if cells are growing in nutrient-rich media, when macroautophagy is blocked, cells perceive themselves as starving (perhaps due to a decrease in the intracellular pool of amino acids) and will thus produce primary cilia.

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Acknowledgments

I would like to thank the Roth Scholars Program and the Summer Undergraduate Research Program for this project and the members of the Cuervo lab for all their time and support in helping me conduct my research. Supported by NIH/NIA AG021904

Student Researcher

Jennie Kraut is a super senior at Stern College majoring in Biology and minoring in Women's Studies. In addition to being president of Yeshiva University's Medical Ethics Society, Jennie is passionate about scientific research and accepted a Roth Scholars position this past summer at Einstein Medical School. In her free time, Jennie enjoys running both competitively on the Stern Cross Country team as well as leisurely and hopes one day to run a full marathon.

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Molecular Cancer Biology

ESTROGEN RECEPTOR ALPHA SERINE167 PHOSPHORYLATION IS JOINTLY CONTROLLED BY MTOR/S6K1 AND MAPK/RSK PATHWAYS

by

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Resistance to endocrine therapy commonly results during treatment for estrogen-receptor positive breast cancer. One such method of resistance is caused by the ligand-independent phosphorylation of Serine167 on the Estrogen Receptor Alpha, allowing the transcription of estrogen regulated genes to occur in the absence of estrogen. In our study, we aimed to analyze the effects of the mTORC1/S6K1 and MAPK/RSK pathways on the phosphorylation of Serine167. We determined that mTORC1/S6K1 and MAPK/RSK unequally phosphorylate Serine167 at different time intervals. The investigation of the mechanisms underlying the mTORC1/S6K1 and MAPK/RSK pathways in estrogen receptor positive cancers is integral as these pathways may serve as potential targets in combination therapy to prevent resistance to anti-estrogens.

Research conducted as part of a senior honors thesis at Stern College for Women, advised by Dr. Marina K. Holz.

Student Researcher

Tirtza Spiegel is a fourth year Biology major with a concentration in Cellular and Molecular Biology. She aspires to become a physician-scientist with a clinical interest in breast oncology and to run an active research program in cancer genetics and preventive oncology. Tirtza loves hiking and wishes to climb Mount Kilimanjaro by the time she is thirty.

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Molecular Cancer Biology

DETERMINING THE EFFECTS OF ESTROGEN RECEPTOR ALPHA ON S6K1 GENE REGULATION

by

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Estrogen receptor alpha (ER*α*) is overexpressed in nearly 60% of breast cancers and stimulates cancer proliferation by upregulating the genes involved in cellular growth. ER*α* acts as a transcription factor when estrogen, a steroidal hormone, binds to the receptor and induces ER*α* to dimerize. Patients who have ER positive (ER+) breast cancer receive endocrine therapy to target estrogen-ERα binding. However, many patients develop resistance to endocrine therapy as ERα still acts as a viable transcription factor without effective estrogen-ERα binding. Phosphorylation of serine residues on the AF-1 transactivation region of ERα may contribute to this ligand-independent activity of ERα. S6K1, a 40S ribosomal S6 kinase, has been found to phosphorylate Ser 167 on the ERα AF-1 transactivation region, thereby enhancing ERα's transcriptional activity. S6K1 is a serine/threonine kinase that acts downstream of mTOR (mammalian target of rapamycin) and is involved in regulating protein translation and cell proliferation. The S6K1 gene, *RPS6KB1*, is often overexpressed in breast cancer cells.

The objective of the current research was to test whether ERα serves as a transcriptional activator at S6K1's promoter region. Such a mechanism would create a positive feedback forward loop wherein S6K1 increases ERα transcriptional activity and ERα enhances S6K1 transcription. This positive feedback forward loop would explain why both S6K1 and ERα are both frequently co-overexpressed in many breast cancers.

We employed a dual luciferase assay to test whether a positive feedback forward loop does indeed exist between the activities of S6K1 and ERα. Three breast cancer cell lines, MCF7 (ER+), BT474 (ER+), and MDA-231 (ER-) were transfected with plasmid vector pSGG containing the promoter region of S6K1 and controlling the firefly luciferase gene. The luminescence produced by firefly luciferase was normalized by renilla luciferase (under the control of a general promoter). The ER+ cell lines were treated with different dosages of estrogen (E2) while the ER- cell line was treated with different dosages of estrogen along with or without ERα coding plasmids. The results show greater S6K1 promoter activity in the presence of ERα and higher dosages of E2 (Figures 1 and 2), which leads us to conclude that ERα transcriptional activity contributes to the expression of the *RPS6KB1* gene.

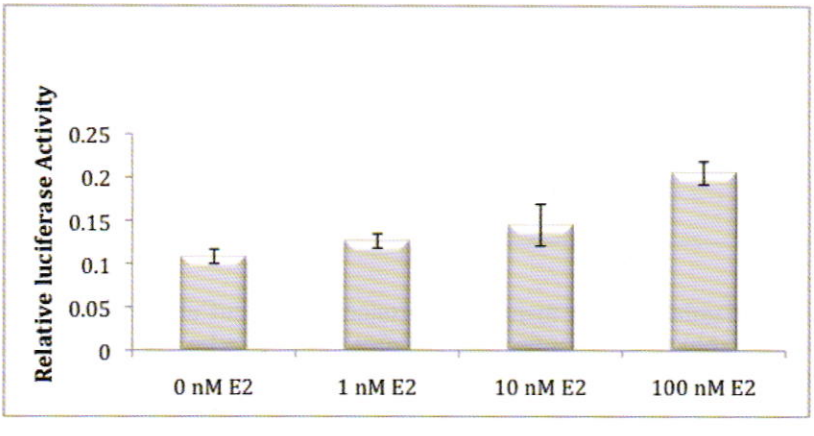

Figure 1. S6K1 promoter activity, as measured by relative luciferase activity, increases when estrogen-depleted MCF7 ER+ cells are treated with increasing dosages of E2.

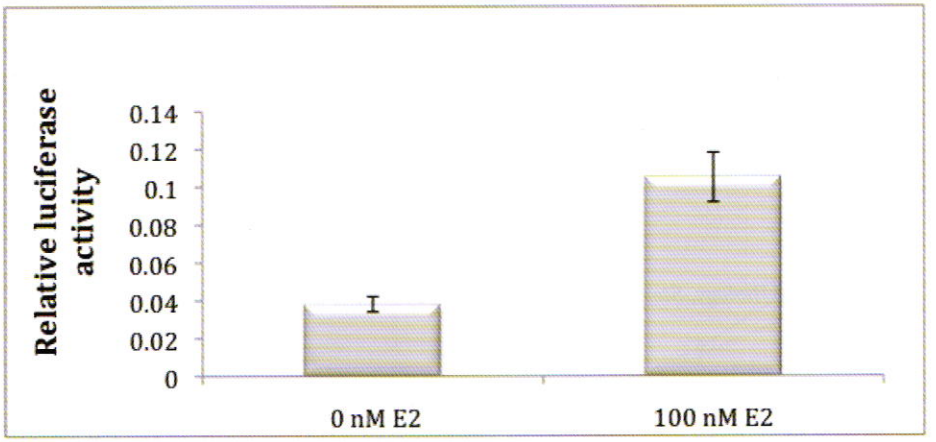

Figure 2. S6K1 promoter activity is significantly greater when estrogen-depleted BT474 ER+ cells are treated with E2.

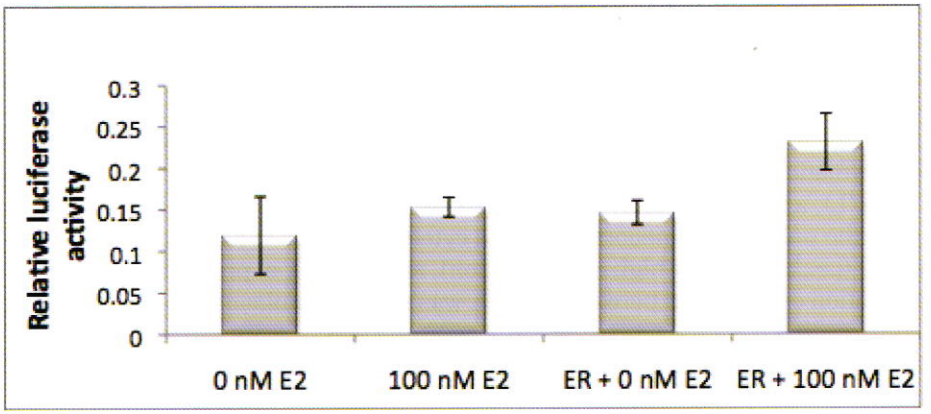

Figure 3. S6K1 promoter activity increases with E2 in cells that express ER in ER-negative MDA-231 cells.

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Student Researchers

Faygel Beren is a senior at Stern College majoring in Biology and minoring in Psychology. Faygel hopes to study medicine with a focus on the needs of those with developmental and mental disabilities. As an energetic participant in clubs on campus that encourage women towards research, Faygel looks forward to continue being involved in biomedical research for many years to come.
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Miriam Steinberger is a junior at Stern College, majoring in Biology, so as to better understand intriguing, everyday biological phenomena such as breathing and circulation. She plans to pursue a career in medicine, because when a person is sick, she likes knowing what to do.
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Molecular Cancer Biology

CYTOTOXICITY OF CRANBERRY JUICE EXTRACT, AS MEDIATED BY CATALASE AND SUPEROXIDE DISMUTASE, TO HSC-2 CARCINOMA CELLS FROM THE HUMAN ORAL CAVITY

by

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Department of Biology, Stern College for Women, Yeshiva University, New York, NY 10016

The effects of cranberry juice extract (CJE) on normal, healthy gingival HF-1 fibroblasts and on HSC-2 oral carcinoma cells were studied. A 24-hr exposure to CJE was toxic to HSC-2 carcinoma cells, as evaluated with the neutral red (NR), with a midpoint cytotoxicity value (NR_{50}) of 200 µg/ml, but was without effect to HF-1 human fibroblasts (Fig. 1).

Generation of hydrogen peroxide in CJE-amended cell culture medium (DMEM) was determined with the FOX assay. CJE generated hydrogen peroxide, albeit to a limited extent as compared to that from other natural products, both in a concentration and in a time dependent manner (Fig. 2). The generation of hydrogen peroxide was not noted in medium co-amended with 250 µg/ml CJE and 100 Units/ml catalase, as catalase enzymatically degraded the hydrogen peroxide to water and molecular oxygen.

The toxicity of CJE to HSC-2 cells was lowered ($P \leq 0.05$) in the presence of 400 Units/ml catalase, reflecting the enzymatic decomposition of hydrogen peroxide, but was unaffected in the presence of pyruvate (110 mg/L), a scavenger of hydrogen peroxide. The relatively low generation of hydrogen peroxide by CJE, the only slight amelioration of the cytotoxic effects of hydrogen peroxide at only 400 Units/ml catalase (i.e., a relatively high concentration), and the lack of protection by pyruvate suggested that the generation of hydrogen peroxide by CJE was not the dominant factor in its cytotoxicity.

Attention then focused on superoxide and exogenously added superoxide dismutase (SOD), an enzyme which catalyzes the dismutation of the superoxide radical to hydrogen peroxide. In the presence of 100 Units/ml SOD, only minor amounts of hydrogen peroxide were detected in CJE-amended medium. To confirm that the lack of detection of significant amounts of hydrogen peroxide in medium coamended with CJE and SOD was not due to protein-peroxide scavenging interactions, studies were done in medium coamended with CJE and bovine serum albumin (BSA). The level of hydrogen peroxide detected in CJE-amended medium was unaffected by BSA, added to the medium at a protein concentration (20 µg/ml) equivalent to that of SOD (Fig. 3). Apparently, SOD inhibited the generation of hydrogen peroxide from CJE, as has been observed for interactions between SOD and EGCG, the main polyphenol in green tea (Nakagama et al. 2004, Carcinogenesis 25:1567-1574).

Interestingly, in the presence of 100 Units/ml SOD, the cytotoxicity of CJE was greatly potentiated to the HSC-2 cells (Fig. 4), as was noted by others for EGCG [Nagakawa et al. (2007, Biochem. Pharmacol., 73:34-43). Yen et al. (2004, Free Rad. Res., 38:193-200)] noted that green tea polyphenols generated superoxide and suggested that in the presence of exogenously added SOD, superoxide was dismutated to hydrogen peroxide, which underwent a Fenton reaction with ionic iron (Fe2+) to generate the highly toxic hydroxyl free radical

The studies herein noted that carcinoma cells were more sensitive than normal fibroblasts to the toxicity of CJE and that the toxicity of CJE was related to the generation of reactive oxygen species, presumably due to the superoxide free radical and, to a lesser extent, to hydrogen peroxide. Further studies are needed to identify the generation of the superoxide free radical from CJE.

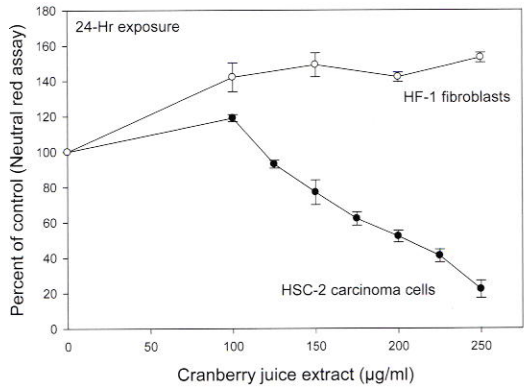

Fig. 1. Comparative sensitivities of HSC-2 and HF-1 cells to a 24-hr exposure to CJE. Data are expressed as the mean percent of control ± SEM.

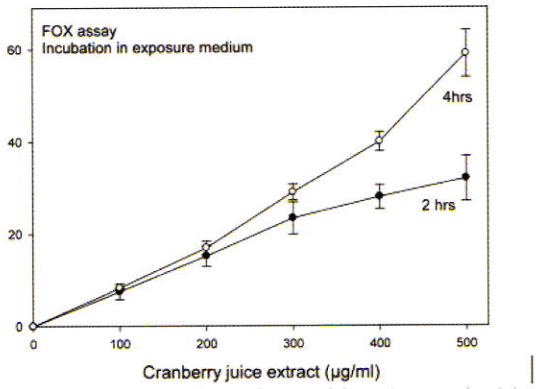

Fig. 2. Generation of peroxides, detected with the FOX assay, in cell culture medium amended with CJE. Data are expressed as the arithmetic mean ± SEM.

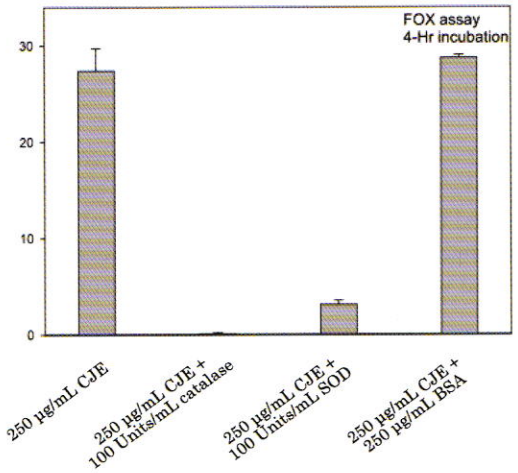

Fig. 3. Generation of peroxides, detected with the FOX assay, in cell culture medium amended with CJE in absence and presence of catalase, superoxide dismutase (SOD) , and bovine serum albumin (BSA).

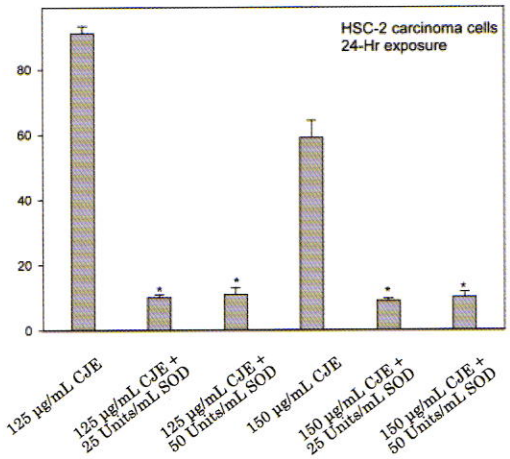

Fig. 4. Potentiation of the cytotoxicity of CJE to HSC-2 cells in the presence of superoxide dismutase (SOD). Data are expressed as the mean percent of control ± SEM.

Student Researcher
Ilana Ickow is from Ocean, NJ, and is a junior, Biology major, and pre-dental student at SCW. When she is not planning events for the Pre-Dent Club or involved in Chemistry Club activities, Ilana enjoys playing her piano and flute, reading, and graphic design
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Molecular Cancer Biology

OLIVE EXTRACT, A PROOXIDANT WITH ANTIPROLIFERATIVE AND PROAPOPTOTIC ACTIVITIES TOWARD ORAL CARCINOMA CELLS

by

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Thirty percent of all cancers are linked to poor dietary habits. The consumption of fruits and vegetables are potential chemo-preventive lifestyle choices, in that their daily intake can potentially prevent cellular changes leading to cancer. The health benefits of these natural products have been attributed to their antioxidant properties, which are due to a high content of soluble polyphenols. Research in our laboratory, however, has indicated that polyphenol-containing extracts from green tea, black tea, and Gingko biloba also exhibit prooxidant activity, which could contribute to their anticarcinogenic effects.

Olives (Olea europaea) and olive oil are major components of the diets of populations around the Mediterranean basin. The low occurrence of cancer in this region has been linked to their dietary habits, including the intake of olives. The primary phenolic components of olives, and those to which the antioxidant and anti-inflammatory activities are attributed, are verbascoside and hydroxytyrosol. While the anticarcinogenic properties of an olive extract (OE) have been established, the cellular mechanism of cytotoxicity toward cancer cells has not. Thus, the antiproliferative, proapoptotic, and prooxidative effects of olive extract (OE) were studied in vitro, using cells derived from the human oral cavity.

OE demonstrated greater antiproliferative effects on HSC-2 oral carcinoma cells in comparison to their normal counterparts, HF-1 gingival fibroblasts (Figure 1). These results correlated with the generation of reactive oxygen species (ROS) by OE, as determined by the ferrous oxidation-xylenol orange (FOX) assay. The antiproliferative effect of OE was linked to its induction of oxidative stress, as the cytotoxicities of the extracts were attenuated in cells co-treated with the ROS scavengers—pyruvate, the divalent cobalt ion, and the enzyme, catalase (Figure 2).

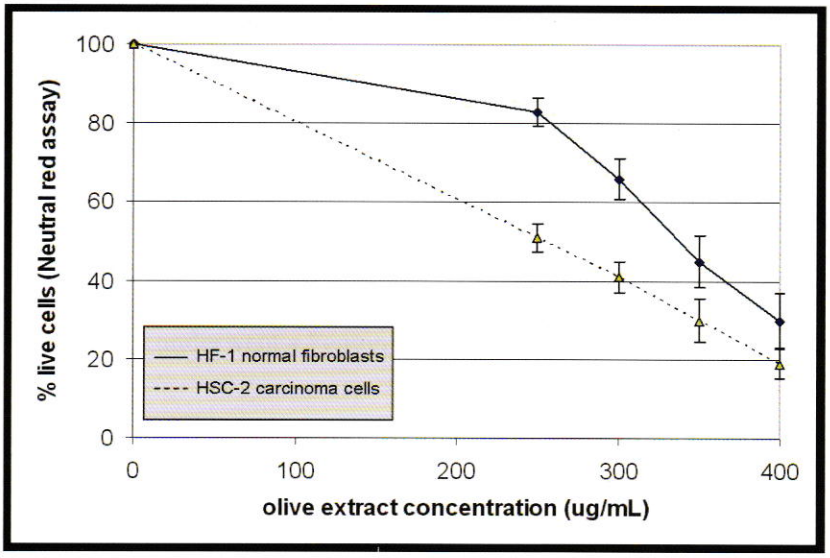

Figure 1. Comparative cytotoxicity of olive extract to HF-1 normal fibroblasts and HSC-2 oral carcinoma cells.

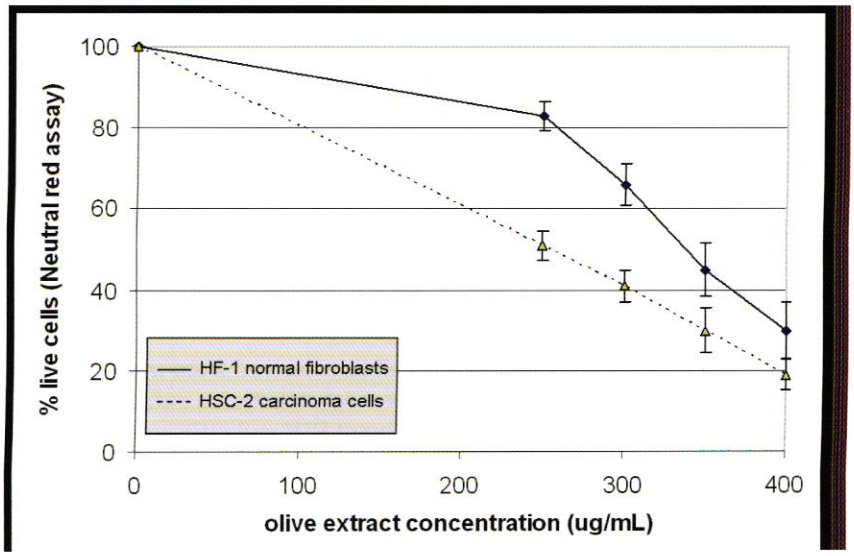

Figure 2. Protective effects of catalase, divalent cobalt ion, and pyruvate toward OE cytotoxicity in HSC-2 cancer cells.

Oxidative stress is one trigger of apoptotic cell death. OE demonstrated pro-apoptotic effects on HSC-2 cells, as detected by immunoblot analysis of cleaved poly (ADP-ribose) polymerase (PARP). PARP cleavage occurred in cells co-treated with OE and cobalt to a lesser extent than in cells treated with OE alone, further establishing the role of OE in the generation of ROS as triggering apoptosis. Together, these data suggest that the anticarcinogenic effects of OE may be due, in part, to its ability to induce oxidative stress, and thereby apoptosis, of cancer cells.

This research was initially presented at the Columbia Undergraduate Research Symposium- Spring 2011.

Student Researchers

Jennifer is a senior at Stern College majoring in Biology and History. She is President of the History club at Stern, volunteers for the Medical Ethics Society, and is a TA for microbiology. Outside of school Jennifer volunteers at a local synagogue and Beth Israel Medical Center. She is planning to pursue a career in Nurse Anesthesiology.
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Shira is a junior at Stern College majoring in Biology. She aspires to become a dentist and to work with a diverse population of patients, including those with mental disabilities. She is a staff writer for the school newspaper and enjoys figure skating in her free time.
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Erica Hasten is a junior at Stern College and is majoring in Biology with a concentration in Molecular and Cellular Biology. Erica hopes to pursue more research opportunities in the future. Erica is a proud member of Stern's soccer team, choral ensemble, and layout staff of the Observer.
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COMPARATIVE RESPONSES OF HSC-2 CARCINOMA CELLS TO EXTRACTS FROM POMEGRANATE JUICE AND OLIVE FRUIT: CORRELATIONS WITH THEIR PROOXIDANT ACTIVITIES

by

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Preliminary studies with HSC-2 cells, a carcinoma cell line derived from malignant tissue in the human oral cavity, showed their greater sensitivity to pomegranate juice extract (PJE) than to an olive fruit extract (OFE). Figure 1 shows the 24-hr cytotoxicity of PJE and OFE towards HSC-2, with cell viability quantified by the neutral red assay. Photomicroscopy of extract-treated cells showed more cellular aberrations upon treatment with PJE than with a comparable concentration of OFE (Figure 2).

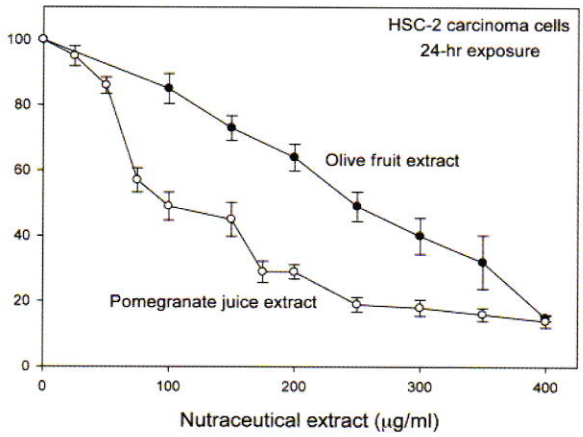

Figure 1. Comparative cytotoxicity of PJE and OFE to HSC-2 cells exposed for 24-hr in Dulbecco's modified Eagle's medium (DMEM), lacking pyruvate.

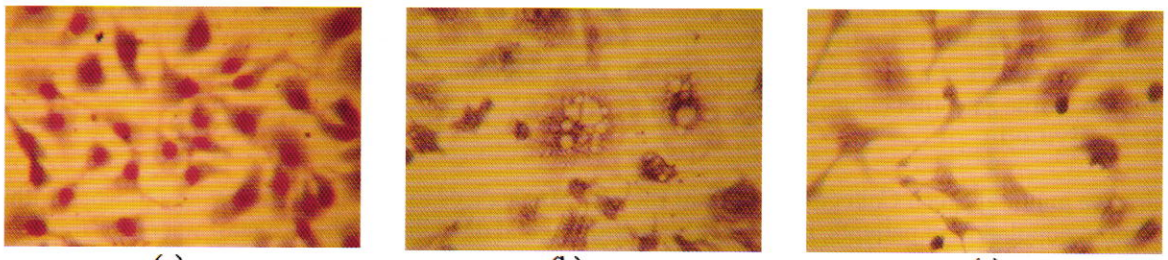

Figure 2. HSC-2 cells: (a) untreated control; (b) treated with 250 μg/ml PJE; and (c) treated with 250μg/ml OFE. Aceto-orcein stain; 320X.

These nutraceutical extracts contain a variety of chemical components and identifying the specific component(s) leading to the greater cytotoxicity of PJE than of OFE was not possible. Current research has indicated that extracts from fruits exhibit prooxidant activity, which may be a contributing factor towards the differential toxicities of PJE and OFE. Using the FOX assay, the generation of hydrogen peroxide in PJE- and OFE-amended cell growth media was compared. In all the commercially-available media studied (DMEM, MEM, McCoy's, RPMI), the generation of hydrogen peroxide was much greater with PJE than with OFE. Carcinoma cells are known to have compromised defense mechanisms against oxidative stress. The enhanced generation of hydrogen peroxide in PJE-amended medium, as opposed to OFE-amended medium, may explain the greater cytotoxicity of PJE than of

OFE to the HSC-2 carcinoma cells. The greater prooxidant activity of PJE, than of OFE, was also noted in their comparative abilities to interact with reduced glutathione (GSH), a tripeptide and the cell's main defense against oxidative stress. In a cell-free assay, the level of authentic GSH was lessened more quickly in the presence of PJE, than of OFE (Figure 3).

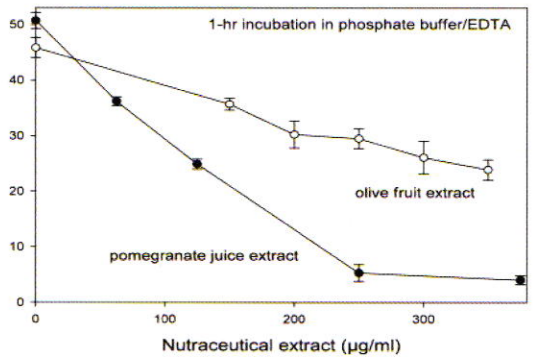

Figure 3. Direct interaction between authentic GSH and either PJE or OJE, as a function of extract concentration.

The above-noted cell culture media lacked sodium pyruvate, a scavenger of hydrogen peroxide. In a commercially-available DMEM containing sodium pyruvate and amended with either PJE or OFE, hydrogen peroxide was not detected. The toxicity of PJE, at 200 and 250 µg/ml, and of OFE, at 250 and 300 µg/ml, to the HSC-2 cells was significantly lowered when exposure was in DMEM with pyruvate (110 mg/L), than in pyruvate-free DMEM (Figure 4).

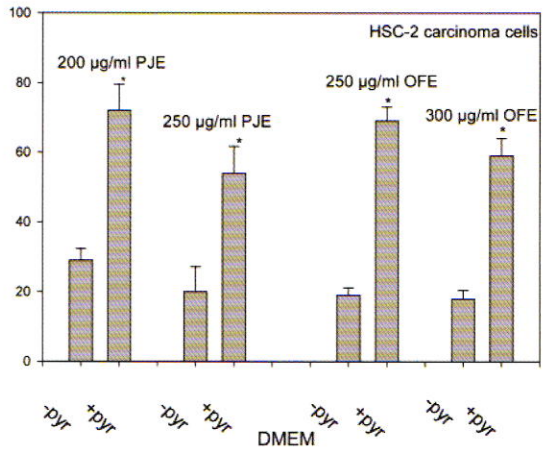

Figure 4. Comparative toxicities of PJE and OFE in pyruvate-containing and pyruvate-free media.

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Sarit Cohen is currently a Junior at Stern College for Women completing her major in Biology. Ever since her first science fair, she knew she wanted to pursue a career in the field of medicine. Aside from pipets, petri dishes, and test tubes, Sarit also enjoys playing tennis and tutoring Chemistry at her local public school.
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Mathematical Economics

STOCHASTIC PROCESSES AND TIME-SERIES ANALYSIS WITHIN THE UNITED STATES SOCIAL SECURITY SYSTEM

by
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Accounting for almost 25% of all government expenditures, Social Security is currently the largest single domestic spending program in the United States of America .The annual determination estimate of its surplus or shortfall is based on an actuarial model that utilizes stochastic time-series analysis, including the Modified Autoregressive Moving Average (ARMA) and vector autoregression models, and as well as stochastic processes,. Specifically,, utilizingincluding theModified Autoregressive Moving Average (ARMA) modeland vector autoregression models, as well as Monte Carlo generation methods are used in generating the random error term. In this paper, I examine and explain the model and its demographic and economic parameters, focusing largely on the unemployment, inflation, and real interest rates rate as it isthey are used within the model.

Furthermore, I recreate the model using updated, accurate figures for unemployment, which has spiked to above 9% during the most recent recession. While the initial model, implemented by the Chief Actuary in 2004, worked with near-6% unemployment, a recreation of the model with updated figures for unemployment, inflation, and the real interest rate provides a more accurate insight into where the system stands today. To replicate the method of Monte Carlo, a random number generator is used based on the method developed by Park and Miller in 1988. The model's results suggest that in 2085, inflation and the real interest rate will deviate from initial expectations adversely, though unemployment will remain largely identical to initial long-term projections.

Research conducted as part of a senior honors thesis at Stern College for Women, advised by Dr. Kira Adaricheva.

Student Researcher
Adina Erdfarb is a senior at Stern College for Women, majoring in Mathematics and Economics with a minor in Business & Management. She plans to pursue a career as an actuary. Adina is also a tutor at the Stern College Writing Center and producer of "So You Think Stern Can Dance," Stern's annual dance performance.

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Artificial Intelligence

ORDERED DIRECTNESS AND EFFICIENTLY COMPUTING CLOSURES

by
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Implications of the form A→B (read "A implies B") feature prominently in multiple fields of mathematics and computers science. In mathematical terms we may define A→B as a mapping from one set to another. In Database Systems, A→B is called a functional dependency and indicates that an assignment of values to set A uniquely determines the corresponding values in set B. For example, a specific value in the "Unique_Course_Code" field of a university database might determine the corresponding Subject and Instructor. In Artificial Intelligence, a Horn clause A→B takes on the common logical meaning "if A is true then B must be true." Representing knowledge as Horn clauses allows us to easily derive new information from existing knowledge.

When we possess large quantities of data in the form of Horn clauses, we often seek to store that data as compactly as possible. The Canonical Basis described in [1] was mathematically proven to represent information using the fewest implications possible. However, the Canonical Basis is not direct, meaning that it may require many iterations of the basis to derive all the implications of a given set of data. We demonstrate that the Canonical Basis is not even ordered direct, meaning that no matter how we arrange its implications, the basis will still require multiple iterations. This puts the Canonical Basis at a profound disadvantage to Adaricheva and Nation's recently discovered D-Basis [2]. We conclude by comparing the efficiency of finding implications from the Canonical Basis, the D-Basis and its derivative E-Basis, and further comparing the time and space efficiency of iterating through the D-Basis to the forward chaining algorithm introduced by Dowling and Gallier [3].

Research conducted as part of a senior honors thesis, advised by Dr. Kira Adaricheva.

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[3] W.F. Dowling and J.H. Gallier, Linear-time algorithms for testing the satisfiability of propositional horn formulae, J. of Logic Programming. 1, 3, (1984), 267-284

Student Researcher
Robert Rand is a fourth-year student at Yeshiva College, majoring in Mathematics and Computer Science. He aspires to build advanced artificial intelligences whose utility functions minimally correlate with those of humanity as a whole.
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Biophysics

TOPOLOGICAL PHONON MODES IN FILAMENTOUS STRUCTURES

by

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Topological phonon modes are robust vibrations localized at the edges of special structures. Their existence is determined by the bulk properties of the structures and therefore cannot be removed no matter what changes occur at the edges. The first class of topological phonons was recently found in structures similar to microtubules. The present work introduces another class of topological phonons, this time occurring in quasi one-dimensional filamentous structures with inversion symmetry. These new structures were inspired by both actin and intermediate filaments, two filamentous macromolecules present in most live cells. They probably represent the simplest structures that support topological phonon modes, a fact that allows detailed analysis in both real time and frequency domains. We give a topological classification of such structures, present an explicit example of topological phonon modes, and analyze these modes in both frequency and time domain. We advance the hypothesis that the topological phonon modes are ubiquitous in the biological world and that living organisms make use of them during various processes.

Topological phonon modes can explain the polymerization process of microfilaments. Microfilaments are made of the protein actin, arranged in a double-helical formation. A pool of ATP-actin monomers is present in the cell, and actin polymerization draws on this pool. The ATP-monomers collide and bond with the ends of the existing filament branches, elongating them. The bound ATP-actin hydrolyzes into ADP-actin almost instantly, releasing quanta of about 12 kT energy.
According to the Elastic Brownian ratchet model, the microfilaments vibrate as spring-like wires and the edges adjacent to the cell membrane bend laterally, exposing the ends to the pool of ATP-actin. This allows additional actin monomers to squeeze in and attach themselves to the ends of branches. The restoring force straightens the Microfilament, which pushes against the cell wall generating the motile force.

We hypothesize that the bending of the microfilaments is caused by topological edge modes, powered by the 12 kTs released during hydrolysis of the ATP-actin. The present work demonstrates the existence of such modes in filamentous structures similar to that of the microfilaments. As we saw through explicit simulations, such edge modes do not allow the energy to dissipate into the bulk of the filaments, and could indeed lead to vigorous shakeup of the ends of the structures, even when excited with weak stimuli. The modes discussed in this work are of a different type from those previously found in microtubules, which required a 2D structure and special interactions. We do not exclude the fact that newly found modes may exist in microtubules.

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The full paper appeared in Physical Review E 83, 021913 (2011)

Student Researchers

Kira Joel is in her second year at Stern College for Women. She is a Physical Sciences major with a concentration in mechanics and hoping to go into engineering. She has enjoyed the physics research she has done so far and looks forward to new research experiences in the future.
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Nina Berg is currently in her third year at Stern College's Honor Program. She is part of the combined plan engineering program at Yeshiva University, and plans to attend Columbia University this coming fall. She is majoring in Computer Science and Computer Engineering.
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Miri Koolyk is completing her second year at Stern College for Women as a Physical Sciences major. She enjoys the scientific well-roundedness of the Physical Sciences program, and hopes to do her concentration in Chemistry. A second focus of her studies is in Talmud, both in and out of Stern College.
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Network Theory

INTERDEPENDENT NETWORKS WITH IDENTICAL DEGREES OF MUTUALLY DEPENDENT NODES

by

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We studied the problem of failure of two interdependent networks in the case of identical degrees of mutually dependent nodes. We assumed that both networks (A and B) have the same number of nodes N connected by bidirectional dependency links establishing a one-to-one correspondence between the nodes of the two networks in a such a way that the mutually dependent nodes have the same number of connectivity links; i.e., their degrees coincide. This implies that both networks have the same degree distribution P (k). We call such networks correspondently-coupled networks (CCNs). We also assumed that the nodes in each network are randomly connected. We defined the mutually connected clusters and the mutual giant component as in earlier works on randomly coupled interdependent networks and assumed that only the nodes belonging to the mutual giant component remain functional. We assumed that initially a $1 - p$ fraction of nodes are randomly removed because of an attack or failure, and found analytically, for an arbitrary $P(k)$, the fraction of nodes $\mu(p)$ that belong to the mutual giant component.

We found that the system undergoes a percolation transition at a certain fraction $p = p_c$, which is always smaller than pc for randomly coupled networks with the same $P(k)$. We also found that the system undergoes a first-order transition at $p_c > 0$ if $P(k)$ has a finite second moment. For the case of scale-free networks with $2 < \lambda \leq 3$, the transition becomes a second-order transition. Moreover, if $\lambda < 3$, we find $p_c = 0$, as in the percolation of a single network. For $\lambda = 3$ we found an exact analytical expression for $p_c > 0$. Finally, we found that the robustness of CCNs increases with the broadness of their degree distribution.

The full paper appeared in Physical Review E 83, 016112 (2011).

Student Researcher

Nathaniel Shere is a second year Mathematics major and Physics minor at Yeshiva University. He plans to pursue a career in the field of cryptography and one day, perhaps, to work for the NSA. In his spare time he enjoys football, good books, and watching Butler in the NCAA Championship games.

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Quantum Mechanical Physics

UNCERTAINTIES FOR THE COHERENT STATES OF THE HARMONIC OSCILLATOR

by

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In this project we study the uncertainty of the coherent states of the quantum-mechanical harmonic oscillator. We first explore the symmetries in position and momentum wavefunction representation with dimensionless variables. With the correct conversion to dimensionless variables, the eigenvalue's time-evolution transforms as a circular rotation. Real and imaginary components of the eigenvalue describe the particle's time-dependent mean position and momentum.

We also derive time-dependent position and momentum wavefunctions. These wavefunctions then allow direct calculation of the quantum entropy. We carefully define entropy for a continuous function, based on its arithmetic deviation from a reference Gaussian with variance $1/(2\pi e)$. With this definition, Shannon and Renyi entropies have identical values, with dimensionless position- and momentum-entropies each emerging as $\log(\pi e)/2$. The generalization of Tsallis entropy to the continuous case must be achieved with a quotient rather than a difference and seems to carry less mathematical meaning.

Student Researcher

Mordechai Kornbluth is a third-year student at Yeshiva College pursuing a major in Physics and minors in Mathematics and Semitic Languages. In his spare time, he enjoys intellectual pursuits such as physics research and rigorous Talmud analysis, as well as listening to classical music. After completing the YC Honors Program, he expects to study for a Ph.D. in physics, followed by a career in research.

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Particle Physics

TOPOLOGICAL MODELING OF D DECAYS

by

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Due to our inability to compute Quantum Chromodynamics (QCD) and the failure of the factorization method to produce results that agree with experiment, charm decays have been quite hard to model. The topological method aims to get around these difficulties by assigning amplitudes to different decay topologies, assuming that these include all the QCD effects. While not *a priori* predictive, once suffcient decays have been studied, it is possible to forecast future decays. Due to the need for experimental results, this method is currently only fully usable for pseudoscalar-pseudoscalar (PP) and vector-pseudoscalar decays (VP) that are not doubly Cabibbo-suppressed. However, this method also fails for PP singly Cabibbo-suppressed decays, as some decays with the same topologies have vastly different amplitudes. This may be due to effects not included in the model which only become important at lower amplitudes. Additionally, SU(3) breaking contributes to the difference between the D^0 to K^+K^- and $\pi^+\pi^-$ decays. PP Cabibbo-favored decays can be well-approximated with least $x2$ fit using topologies, with a low $\chi 2$ of about 0.1. Additionally, such decays can be used to study $\pi 0 - \eta - \eta'$ mixing. VP Cabibbo-favored decays can be described by numerous different fits, due to the doubling of decay modes with each topology split into two, depending on whether the spectator quark ends up in the pseudoscalar or vector final product. These fits work well for all decays except for the D_8+ to $\rho+ \eta$ and especially to $\rho+ \eta'$. However, only two of these fits even approximate the singly Cabibbo-suppressed decays, which are again plagued by SU(3) breaking amplitudes. Due to the relative lack of data, scalar-pseudoscalar (SP) and tensor-pseudoscalar (TP) decays can only be studied by combining Cabibbo-favored and suppressed decays, making certain simplifying assumptions, and in the case of TP decays, only modeling certain topologies.

Research Conducted as part of the 2010 REU at Wayne State University.

Student Researcher

Joshua Blumenkopf is a second year Physics and Mathematics major, who would love to be convinced of the reality of the universe. In his spare time he debates anyone within earshot and listens to classical music.

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Cognitive Psychology

THE EFFECTS OF A DETERMINISTIC PHILOSOPHY ON WELL-BEING AND POSSIBLE MODERATING FACTORS

by

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Belief in causal determinism is a fertile source of both thought and research. However, most of this research has been focused on its behavioral effects. Through an experiment (N=400) priming participants against belief in free will, we will focus on the effect of belief in determinism on a person's wellbeing.

Determinism suggests that every event, including human action, is directly caused by a physical antecedent (Hoefer, 2010), and stands in complete opposition to free will. We hypothesize that reducing belief in free will should significantly lower well being, as measured according to hedonic (Kahneman, Diener and Schwartz, 1999) and eudaimonic (Ryan and Deci, 2001) constructs. Furthermore, we will test for possible moderating factors, including socioeconomic status, locus of control, individualism/collectivism, and religiosity. We hope that this research will produce findings that will enhance our understanding of the processes underlying happiness and demonstrate the psychological consequences of an individual's philosophical worldview.

Research conducted as part of a senior honors thesis at Yeshiva College, advised by Dr. Ariel Malka.

Student Researcher

Benjamin Katz is a senior in the Jay and Jeannie Schottenstein Honors Program at Yeshiva College, where he is majoring in Psychology. Over the course of his two year research assistantship in the lab of Dr. Jenny Isaacs, he has assisted in the production of numerous research articles, once as a co-author. Benjamin has also presented his research in the United States and abroad.

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Cognitive Psychology

THE ASSOCIATION BETWEEN SOCIOECONOMIC DISPARITIES AND NEUROCOGNITIVE FUNCTIONING IN CHILDREN: A REVIEW OF THE LITERATURE

by

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Socioeconomic status (SES) has been known to be associated with children's cognitive development. Various studies have found associations between proximal factors purported to be related to SES, such as environmental stimulation, parental education and nurturance, on language, memory and executive functions. However, most SES studies are correlational and examine more generalized cognitive function and academic achievement such as child IQ, grade repetition and GPA, rather than specific cognitive systems. Although those measures reflect the overall function of the brain, they do not provide information about which specific neurocognitive systems are associated with SES. A series of studies using behavioral tasks selectively engaging a variety of neurocognitive systems was done to investigate which socioeconomic disparities are associated with performance in one system relative to another. Socioeconomic disparities can now be associated with a 'profile' of neurocognitive systems involving language, phonological awareness, memory, executive functions, cognitive control and spatial cognition in early childhood. However, this research is limited by homogeneity of samples, with primarily African American children of low SES. Future studies should incorporate children of higher SES and diverse ethnicities. Nonetheless, these results are important to consider in the design of programs for educational interventions with low SES children.

Student Researcher

Liorah Sabbah grew up in Tahiti and moved to New York after high school. She is a senior at Stern College majoring in Psychology and minoring in Biology and is part of the new Neuroscience track at Stern. Liorah aspires to obtain a PhD in Clinical Neuropsychology with an emphasis in traumatic brain injury.

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Neuropsychology

THE EFFECTS OF AGE, EXOGENOUS HORMONES, AND MENSTRUATION ON OBJECT MEMORY AND SPATIAL ABILITY IN WOMEN

by

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The present investigation on women and cognitive decline had two primary goals: The first goal was to determine if aged women demonstrate cognitive decline on tests of object memory and spatial ability compared to young women. The second goal of this study was to investigate the effects of exogenous hormones and menstruation on women's cognitive ability as measured using these same tests. Forty young undergraduate women (ages 19-24) were compared to twenty-nine aged independent living women (ages 71-90). A personal information questionnaire was administered just before testing allowing for comparisons of results for aged women on hormone therapy with those who where not on hormones. A similar questionnaire was administered for young women to compare those on birth control hormones with those not using birth control, and finally for young menstruating women with those not menstruating during the time of testing. An object array task was used to measure object memory and a mental rotation test (MRT) was used to measure spatial ability. Preliminary results suggest that young women had significantly better object array task scores ($p < .05$) and MRT scores ($p < .0001$) compared to aged women. This indicates age-related cognitive decline in object memory and spatial ability in older women. Furthermore, aged females who used hormone therapy performed worse on all object array conditions with significant results for the object shift condition ($p< .05$). Hormone therapy did not significantly affect MRT scores in aged women ($p> .05$). Other preliminary results of this investigation indicate that hormone birth control use did not significantly affect performance on the object array task ($p>.05$) or the MRT ($p>.05$) for young women. Finally, the results demonstrated that menstruation did not significantly affect performance on either the object array task ($p>.05$) or the MRT ($p>.05$).

Student Researcher

Danielle Taylor is a recent Stern College graduate who majored in psychology. She is currently managing Dr. Lauren Harburger's research laboratory at Stern College and assisting with her research studies. Danielle hopes to continue on to graduate school and become a clinical psychologist.

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Social Psychology

SOCIAL-COGNITIVE PREDICTORS OF BULLYING

by

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Bullying is a widespread problem that often occurs in the presence of others. Social cognitive learning theory states that behavior can be learned through observations of others and that cognitions about social behavior may fuel one's behavioral choices. The current study examines whether perceptions of peer bystander behavior and adult responsiveness to bullying predict personal bullying behavior, and if this association is mediated by attitudes about bullying.

A series of self-report questionnaires were given to 320 middle school students that assessed adult and peer responsiveness to bullying, pro-bullying attitudes, pro-social problem solving skills, and bullying behavior. Results reveal that both higher perceptions of positive peer bystander behavior and adult responsiveness were predictive of less bullying behavior, but this association was largely mediated by attitudes about bullying. In addition, attitudes about bullying were predictive of bullying behavior, but the relationship was moderated by pro-social problem solving skills, such that the relation was strongest when children were lower in pro-social problem solving strategies. Findings suggest that the ways that others respond to bullying may influence the way children themselves want to respond, and social cognitions may partially account for this association. Additionally, results suggest that interventions should put an emphasis on teaching pro-social problem solving skills to help mitigate the relation between pro-bullying attitudes and bullying behavior.

Student Researcher

Charles Borgen is a senior at Yeshiva College. He is majoring in Psychology and intends to attend a graduate program in this subject. He is studying bullying and its various predictors under the tutelage of Dr. Isaacs.

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Social Psychology

PREVALENCE AND PREDICTORS OF ACADEMIC DISHONESTY IN RELIGIOUS UNDERGRADUATES

by

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Research has found that 70% to 90% of college students have cheated at least once. Among business students, the prevalence is even higher, with up to 95% admitting to cheating. Given the high prevalence of cheating in college students, identification of factors associated with cheating behaviors is of importance to both researchers and educators.

The aim of the present study was to assess the prevalence of and identify predictors of cheating in a sample of undergraduates in a Jewish university. Based on prior literature, we proposed that religiosity and learning orientation would be negatively correlated to cheating, while grade orientation would be positively correlated to cheating. Additionally, we proposed that rational and irrational beliefs about grades would be associated with cheating.

The sample included 234 students (58.1% female) from 3 undergraduate colleges (a women's college, a men's college, and a business college). Students completed questionnaires including the LOGO II (assessing learning and grade orientations), a religiosity measure, a modified version of Rettinger and Jordan's (2005) cheating scale (subscales included cheating on tests, papers and homework), an item assessing perceived prevalence of cheating in the college, and a measure of rational and irrational beliefs about grades developed for this study. 87.2% of students reported having cheated at least once; business students reported significantly higher ($p<.01$) rates than students from the men's college. Rates of cheating among students in the women's college did not differ significantly from those of the other colleges.

As predicted, bivariate analyses supported previous findings that cheating is associated with religiosity ($r = -.22$), learning orientation ($r = -.30$), grade orientation ($r = .45$), and perceived prevalence of cheating among peers ($r = .34$) ($p's<.01$). We also found that irrational beliefs were associated with cheating on tests ($r = .13$) and grade orientation ($r = .19$), while rational beliefs were associated with perceived prevalence of cheating ($r = .19$), religiosity ($r = .14$) and grade orientation ($r = -.13$). Contrary to prior research, there were no significant gender differences in cheating. Interestingly, in analyses of the subsample of students who were in at least their second semester of college ($n=148$), the association between religiosity and cheating was no longer significant.

Results indicate that cheating is prevalent in religious undergraduates; however, the relationship between religiosity and cheating was only seen in students who had already completed one full semester of college. Future research should examine the associations between religiosity and cheating over time. The predictors of cheating identified in this study should be considered in interventions targeting cheating.

Student Researcher

Raquel Amram, originally from Venezuela, is currently a senior majoring in Psychology and minoring in Philosophy. As co-founder of the Academic Honesty Committee and by the suggestion of Dean Bacon, she was encouraged to do research on academic integrity under the guidance of Dr. Terry DiLorenzo. She plans to get her PhD in Neuropsychology with a focus in Neuroscience and Education.

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