the Exley

VOLUME 4 SPRING 2015

THE UNIVERSITY OF TEXAS AT DALLAS UNDERGRADUATE RESEARCH JOURNAL

Featuring

The Exley Legacy Updates

Exploring the Other Side of Our Galaxy
— by Madeeha Mian

Solution Processed Metal Oxide Nanoparticles as Hole Transport Layers in Organic Photovoltaic Devices
— by Brandon Adkison

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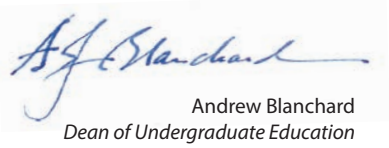
About *The Exley*



Andrew Blanchard
Dean of Undergraduate Education

Dear Readers, As you know, many UT Dallas undergraduate students participate in research activities. Our students interact with the University's faculty, graduate students and postdoctoral professionals. Some undergraduates enroll in courses or participate in programs that provide an opportunity to demonstrate their creative talents. *The Exley*, UT Dallas' undergraduate research journal, supports this process by encouraging students to publish their work where it can be appreciated by a larger community.

The Exley provides undergraduate students from every discipline an opportunity to publish substantive work that illustrates their creative ability or research skills. The Office of Undergraduate Education manages the journal and publishes each issue in collaboration with the Office of Research, the Office of Communications, administrators from our schools, and the University's faculty and students.

The work published in *The Exley* recognizes the dedication of both the authors and their faculty research mentors. I hope these contributions inspire other students to engage in research and share their creative work.

I would like to personally thank Elizabeth Exley Hodge. Ms. Hodge dedicated 19 years to UT Dallas as a valued employee and has continued her contributions by graciously supporting this forum for undergraduates. The Office of Undergraduate Education is very grateful for Ms. Hodge's generosity and commitment to the University's continued excellence in undergraduate education and research.

In the spring of 2011, Ms. Elizabeth Exley Hodge made a generous donation to support the publication of UT Dallas' first interdisciplinary undergraduate research journal. Hodge's maiden name of Exley represents the rich history of her family. The surname Exley, originally Ecclesley, dates to 1245 and means "church fields." Her great-great-grandfather's birthplace is now known as Exley Hall in Yorkshire, England. This journal was named *The Exley* to show the University's appreciation of Hodge's support for undergraduate research.

The Exley Name

Elizabeth Exley Hodge Biography

Elizabeth Exley Hodge was born in 1920 in a small farming community in Worcester County, Maryland. She is one of 11 children of Lola Marie Watson and John O. Exley, gold medalist in rowing at the 1900 and 1904 Olympic Games. She was a Depression-era child, who worked on the family's strawberry and tomato farm with her father and brothers. Entertainment for the children was playing marbles, drawing and playing hopscotch in the sand, flying homemade kites, and swimming in the millpond. Her first five years of education were at a one-room school near her home, and she later graduated from Snow Hill High School, one of 43 members of the class of 1936. It was during her senior year that she became "Libby" to her classmates. After high school, Hodge worked for an insurance company in Philadelphia. During World War II, she volunteered with the U.S. Air Corps, where she met her future husband, Noble H. Hodge, who was from Fannin County, Texas. They married in 1942, and in 1945, after the completion of Noble's military service in England, they settled in Dallas, where Hodge still resides. In 1967, Hodge joined the administrative offices of the Southwest Center for Advanced Studies. When the center became UT Dallas in 1969, she transferred to the Department of Biology in the School of Natural Sciences and Mathematics, where she assisted faculty members in preparing research grant applications. After a number of years in grants management in the School of Natural Sciences and Mathematics, and later in the Office of Sponsored Projects, she retired in 1986. Hodge has been an avid gardener for many years and has a personal arboretum and an orchid hybrid bearing her name. A member of St. John's Episcopal Church, she also enjoys cooking and sharing her time with others and has volunteered weekly for the last 23 years at Baylor Medical Center in Garland.

the Exley
THE UNIVERSITY OF TEXAS AT DALLAS UNDERGRADUATE RESEARCH JOURNAL

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Exley Legacy Updates

These outstanding UT Dallas alumni contributed their undergraduate research submissions for publication in the first issue of The Exley. It is a privilege for the UT Dallas Office of Undergraduate Education to provide the opportunity for students engaged in research to experience publication of their early research endeavors. Congratulations to these past contributors for their outstanding accomplishments since graduating from UT Dallas.

Emily Butler A cum laude graduate of UT Dallas with a bachelor's degree in geosciences in May 2013, Emily currently attends the Colorado School of Mines. She is pursuing a master's degree in geophysics and belongs to a consortium called the Reservoir Characterization Project (RCP), working with advisor Dr. Tom Davis. She aspires to contribute to the characterization of the Niobrara formation in Colorado for hydrocarbon production through the use of multicomponent 4D seismic data. Her plans also include interning with Chevron over the summer and defending her thesis in May 2016.

Larissa Weidenbruch When she was only four years old, Larissa practiced her future teaching vocation on her first pupil, her younger sister. After seeing her work published in the inaugural issue of ***The Exley*** and graduating from UT Dallas, she accepted a teaching position at the same middle school she attended years ago. Larissa teaches seventh-grade English in the same classroom where she received instruction as a junior high student. During her time as a teacher, she has attended curriculum development training and anticipates attending leadership training in the future. In addition to teaching reading, writing and grammar, Larissa utilizes her graphic design and journalism skills overseeing the publication of the school yearbook.

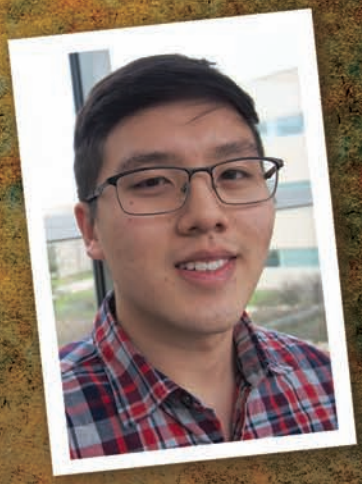
Zachary Johnson Since publishing his research in the first issue of ***The Exley***, Zach obtained two internships within his field, graduated with a master's degree in marketing in May 2014, and currently works as a search engine optimization (SEO) data coordinator at Standing Dog Interactive, a digital marketing agency based in Dallas. His responsibilities include implementing industry-standard SEO tactics on websites and mobile devices, performing SEO data analysis to improve his company's current marketing processes, and automating internal company processes to improve overall company efficiency and data movement. He is grateful to have graduated debt-free, due to the generosity and goodwill of the Terry Foundation. In his free time, he enjoys brushing up on his knowledge of SEO, physics, and philosophy. He is an avid camper in the DFW/Oklahoma region and claims that the fresh air reminds him of his small-town upbringing. He is forever grateful to UT Dallas and to all of the wonderful professors, employees, staff, students and alumni that make him proud to be an alumnus.

Student Advisory Board

***The Exley** welcomes the addition of three undergraduate student researchers to represent their peers as part of the inaugural Student Advisory Board. These students worked closely with the existing Faculty Advisory Board in reviewing and selecting content for **The Exley's** fourth issue. This partnership between students and faculty will serve to provide even more robust content to the journal, and will provide a tremendous opportunity for undergraduate students interested in pursuing research careers.*

Elizabeth Ashley Kennon is a junior biology and physics double major from Houston, Texas, and a graduate of the Texas Academy of Mathematics and Science (TAMS), where she completed her first two years of college at the University of North Texas during her junior and senior years of high school. Ashley's early research endeavors were with the University of Texas Medical Branch's high school summer research program. Mentored in Dr. Yogesh Wairkar's neurology lab, she studied the Tuberous sclerosis complex's interactions with the protein TORC2. Her UT Dallas research experience began in the summer of 2014, with work in Dr. Gail Breen's molecular biology lab, as a scholar in the Clark Summer Research Program. She continues to research in the Breen lab, investigating the relationship between the autophagy-lysosomal pathway and the cytotoxicity of a Tau-derived peptide. Ashley plans to attend medical school and pursue her interest in radiation oncology, where she hopes her strong foundation in both medicine and physics will help save lives.

Audra Jackson is a junior international political economy student from Houston, Texas. She is a peer advisor for Residence Hall Southwest, the president of the Sigma Mu Chapter of Delta Sigma Theta Sorority Inc., and a member of the Black Student Alliance, and has volunteered over 30 hours at the Comet Cupboard. She was a district office intern for U.S. Rep. Eddie Bernice Johnson and a research intern for Dr. Sarah Maxwell. Audra is committed to her studies and ensuring that the UT Dallas community continues to grow and thrive through diversity. Upon graduation, Audra plans to attend graduate school to further her studies in public policy.



Michael Lau is a senior biomedical engineering Collegium V student from Arlington, Texas. He fostered his initial love of research in high school, as he researched in a biomaterials lab at the University of Texas at Arlington. Shortly after enrolling at UT Dallas in 2011, he joined Dr. Danieli Rodrigues' newly established lab and began researching the encapsulation of oral antibiotics with biopolymers. Michael's research pursuits garnered him two consecutive Barry M. Goldwater honorable mentions in 2013 and 2014. In 2014, Lau, along with his research partner, Ridwan Haseeb, won the Undergraduate Research Scholar Awards Contest. He anticipates graduating in the spring of 2015, as a member of the first UTD biomedical engineering graduating class. Lau plans to gain industrial experience for several years before coming back to academia to achieve a higher degree in the bioinformatics/computer science fields.

About the Research Contributors

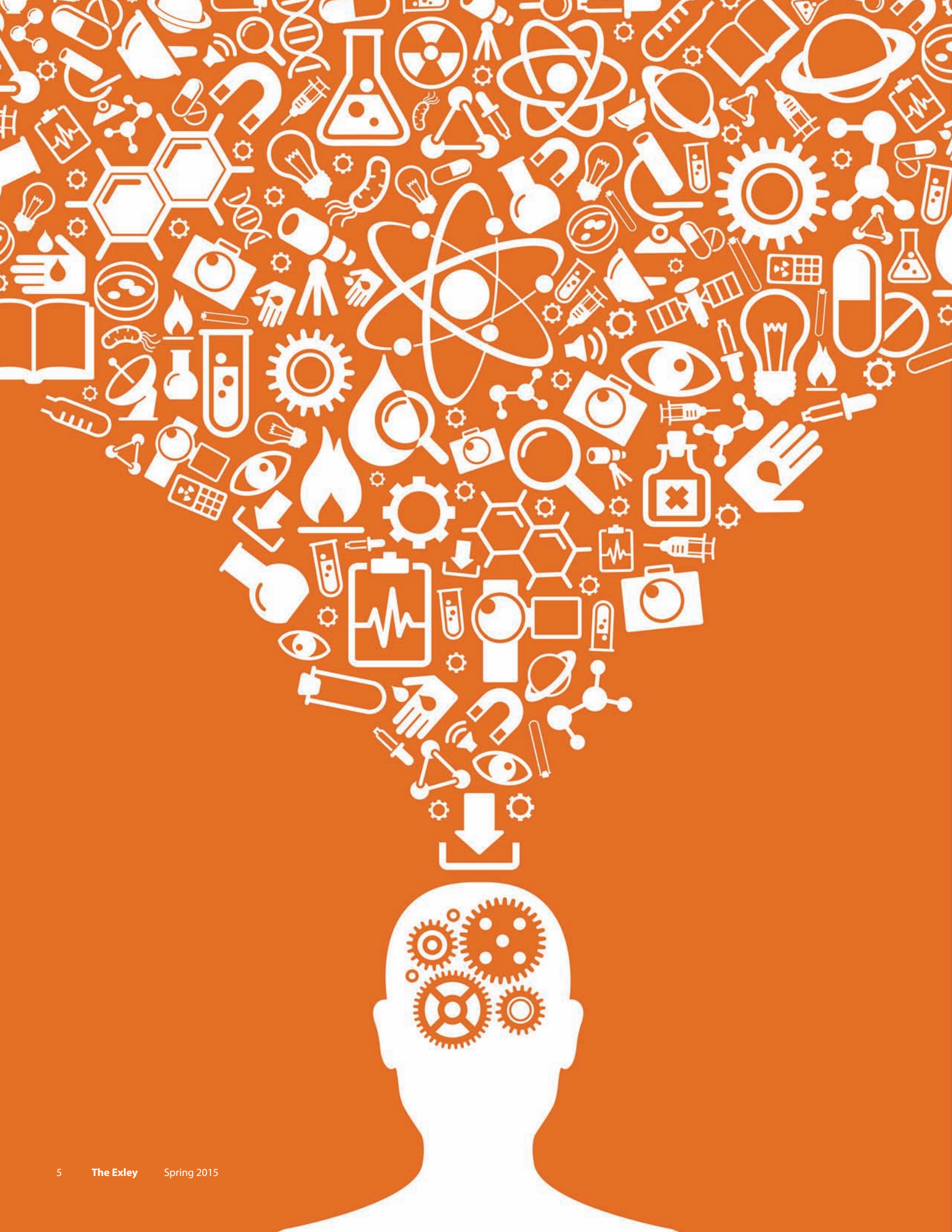
Carrie Crossley is a senior arts and technology major from Southlake, Texas. She started college at the age of 15 and began researching serious games when she was 17. She is passionate about using games as a new medium for education, and wants to explore the pedagogical capabilities for games in traditional classroom settings, as well as in military and health care training. During her years at UT Dallas, Carrie has held multiple research assistantships, worked as a level designer on three student games, and held officer positions in both the Student Game Developers Alliance and the Guild of Level Designers. In her spare time, Carrie enjoys playing guitar, cooking, and going to hockey games. She will be graduating with honors in May, and will continue her studies in graduate school this fall.

Simran Malhotra is a junior biology major on the pre-med track, with Spanish/Hispanic studies and music minors. Simran was born in India, immigrated to the United States at age 3, and settled in Texas at age 13. While in Texas, she met OBGYNs Dr. Julie Vu and Dr. Arlene Jacobs, who inspired her to pursue a career in women's health and women's education reform through medicine. Currently, Simran researches under Dr. Christa McIntyre and Lindsey Noble in a learning and memory lab in the Natural Science and Engineering Research Laboratory at UT Dallas. Outside of academics and research, Simran enjoys cooking, reading and knitting. After graduation, she aspires to study abroad, hone her Spanish-speaking skills, and study Spanish literature.

Brandon Adkison is a senior biochemistry major who was born in Dallas. He grew up in Plano, where he developed an interest in science and math at a young age. He is currently serving in Dr. Julia Hsu's research lab as an undergraduate research assistant where he makes and tests organic solar cells. Brandon is a member of the Delta Epsilon Iota academic honor society and the National Society of Leadership and Success, and played on the UT Dallas men's soccer team. Outside of school, he enjoys traveling the world, snowboarding, playing soccer, golfing, and spending time with family and friends. After graduation, Brandon plans to pursue a career in medical research.

Alexander Burns is a senior chemistry major from Pascagoula, Mississippi. Alexander has been working in the lab of Dr. Luke Rice at UT Southwestern for over a year. Previously, he worked with Dr. Mihaela Stefan at UT Dallas. Alexander is grateful to Drs. Stefan and Rice for their support and guidance in his development as a scientist. When Alexander is not in the lab, he is an avid handbell ringer and director for several local choirs, including Arapaho United Methodist Church. After graduation in the spring, Alexander plans to pursue a doctoral degree in synthetic chemistry or biochemistry.

Aaron Dotson is a senior neuroscience (pre-med) major and music minor with an emphasis in classical piano and composition. He aspires to be a practicing physician, helping to make a positive difference in the lives of others. Aaron is very passionate about mentoring and motivating others to achieve their highest potential. He is a member of the Delta Epsilon Iota Academic Honor Society, Golden Key International Honour Society and the Honor Society of Phi Kappa Phi. Aaron is an alumnus of the Summer Medical and Dental Education Program of the Yale School of Medicine, and was a summer undergraduate research intern of the Johns Hopkins School of Medicine, Division of Pulmonary and Critical Care Medicine. Aaron is currently working on two neuroscience research projects that study the cellular synaptic mechanisms of alcohol and amphetamine addiction. Aaron is also trained in rodent stereotactic neurosurgery, specializing in infralimbic nanoliter injections and infralimbic cannula implantations. Aaron hopes to combine his research findings and medical knowledge to help others fight against disease and disparities.



Undergraduate Research Programs at UT Dallas

Annual Exhibition of Excellence in Undergraduate Research

Each year, the Office of Undergraduate Education and the Office of Research collaborate to host the Exhibition of Excellence in Undergraduate Research. This weeklong series of events allows undergraduates to learn more about research opportunities, to receive recognition for research related accomplishments, and to compete for valuable research awards.

Research Resume Workshop

Students receive valuable advice on how to prepare a scientific/research-oriented resume or strengthen an existing research resume. The workshop, sponsored by the Office of Undergraduate Education, the Office of Research, and the UT Dallas Career Center, also covers best practices for approaching the research interview and guides students in preparing their best presentation during Undergraduate Research Match Day.

The Exley Luncheon

The Office of Undergraduate Education hosts an annual luncheon to celebrate the latest issue of ***The Exley***. This event is open to all students, faculty and staff, and each attendee receives a copy of the most recent issue of ***The Exley.*** Students interested in learning more about publishing in ***The Exley*** are able to receive important best-practice information. Current contributors to ***The Exley***, as well as the annual recipients of the Patti Henry Pinch Scholarship, are recognized during the luncheon.

Undergraduate Research Match Day

The Match Day event is open to all students and is designed to facilitate the process of pairing motivated undergraduates with faculty who are conducting research projects. Students who participate gain valuable research experience that contributes to future success professionally or in graduate school. Faculty who engage undergraduates in research enhance grant applications by demonstrating mentorship while receiving quality researchers.

Undergraduate Research Faculty/Student Panel

Undergraduate students and faculty researchers share their research experiences, tips on competing for research programs and fellowships, and strategies for obtaining the ideal research position.

Undergraduate Research Scholar Awards Poster Contest

Current recipients of the Undergraduate Research Scholar Awards discuss their research with event attendees, utilizing a research poster and their in-person research presentation skills. Research faculty members select two semifinalists per academic discipline, all of whom advance to the final round of judging. The three final winners are selected by members of the external research community.

Provost's Award for Faculty Excellence in Undergraduate Research Mentoring

The Office of Undergraduate Education and the Office of the Provost are pleased to annually recognize an outstanding UT Dallas faculty member who excels in his or her undergraduate research mentoring efforts. The Provost's Award for Faculty Excellence in Undergraduate Research Mentoring seeks to formally acknowledge a faculty mentor who demonstrates superior leadership, support, and guidance toward the development of UT Dallas undergraduate students and their research endeavors. The awarded faculty member receives a one-time cash award and recognition during the spring Honors Convocation ceremony. Announcement of the winner takes place during the annual Exhibition of Excellence in Undergraduate Research. Past winners are Dr. Sven Kroener and Dr. Paul Pantano.

Undergraduate Research Scholar Awards

Undergraduate Research Scholar Awards are made for a single semester and are awarded by the vice president for research. Funds are limited, and awards are made on a competitive basis. The award consists of a cash stipend of $500 paid to the student, as well as an award of $300 transferred to a University account controlled by the faculty sponsor to support the research project (e.g., laboratory equipment, project travel, etc.) or related activities. Cash stipends paid to students are subject to deductions for required taxes. There are no restrictions on the nature of the research—it can be in any field. However, the research must be on a serious, credible topic of inquiry, and there must be a faculty supervisor for the project. At the end of the spring semester, recipients of this grant have the opportunity to join in a poster competition to receive additional funds.

2014 Undergraduate Research Scholar Awards Semifinalists

Yuying Chen
A Longitudinal Study of Political Attitudes in Taiwan Using Pseudo Panel Cohort Analysis
— Political Science

Thao Ngo
Behavioral Economics and Health Economics: The Relationship Among Patience, Saving Behavior and Health
— Economics

David Massey
Emotion Recognition in Cochlear Implant Simulations
— Behavioral and Brain Sciences

Haris Vakil (Winner)
Characterization of Behavioral Changes in a Developmental Ketamine-Treatment Rodent Model of Schizophrenia
— Behavioral and Brain Sciences

Ridwan Haseeb and Michael Lau (Winners)
Poly(ethylene glycol)-block-poly(L-lactide) (PEG/PLA) Encapsulation of Oral Antibiotics for Drug Delivery into Dentin Tubules
— Bioengineering

Ardalan Sharifi Noghabi (Winner)
Antibiotic Resistance and the Emergence of Immune-Deficient Bacteria
— Molecular and Cell Biology

Daniel Galles
Coated Acrylonitrile-Based Terpolymer Prolongs Release of NO for Wound Healing Applications
— Chemistry

Jacob White
Dynamical Analysis of Galaxy Cluster Merger Abell 2146
— Physics

Shane Parris
Smartphone-Based Real-Time Implementation of Cochlear Implant Speech Processing Pipeline
— Electrical Engineering

Emin Bursa
Visualizing Manifolds in Four-Dimensional Space
— Mathematical Sciences

Lidia El Bouanani
Room-Temperature and High Performance Ultraviolet-Blue Light Photodetectors from Cadmium Sulfide Nanoparticles
— Materials Science and Engineering

Sakthi Rajendran
Minimally Invasive Shape Memory Polymer Electrodes
— Materials Science and Engineering

Clark Summer Research Program

The objective of the Clark Summer Research Program is to enrich the academic experience of our students by providing an opportunity for them to conduct hands-on research with some of UT Dallas' nationally recognized faculty and talented undergraduate, graduate, and postdoctoral students. This program seeks to instill the value of research in undergraduate students so that they remain actively engaged in research activities that contribute to their fields of interest and the University throughout their academic and professional careers.

The research and lab experiences afforded to students in this program are rarely offered at the undergraduate level. Students are actively engaged in serious research activities that give them a realistic view of the work conducted in their academic disciplines. Each student is assigned a faculty research mentor for the duration of the program.

2014 Clark Summer Research Scholars

Patrick Bell
Mentor: Anton Malko
The Energy Transfer of Quantum Dots and J-Aggregates

Elizabeth Bentley
Mentor: Danieli Rodrigues
Antibiotic Release from Lactose-Containing Bone Cements

Rachael Buxton
Mentor: Inga Musselman
Synthesis of Porous Metal-Organic Polyhedra MOP-1 for Gas Separations

Kimberly Fiock
Mentor: Theodore Price
Escape Avoidance Paradigm Opens Up the Door for the Assessment of Physical and Psychological Aspects of Pain

Tyler Hagen
Mentor: Andrea Fumagalli
Implementation of an MPLS-Enabled Network in an OMNET ++ Simulation

Kiley Holbert
Mentor: Ravi Prakash
The Digital Backpack: How Technology Can Improve Academic Efficiency and Influence Collaborative Learning

Ethan Honeycutt
Mentor: S. Venkatesan
Configuring Asterisk Voicemail for Open Database Connectivity with MySQL

Karthik Hullahalli
Mentor: Kelli Palmer
A Novel Typing System for Rapid Identification of Multidrug-Resistant Enterococcus faecalis Strains

Ian Kampine
Mentor: John Ferraris
Novel Gas Separation Membranes Derived from Immiscible Polymer Blends Compatibilized with Small Molecules

Elizabeth Kennon
Mentor: Gail Breen
Investigating T-peptide—Induced Cell Death and Rescue in HeLa Cells

Anna Maleug
Mentor: Ronald Smaldone
The Functionalization of b-cyclodextrin for the Synthesis of Soft Polymers

James Murphy
Mentor: Latifur Khan
Big Data in the Medical Field Using RFID Tags

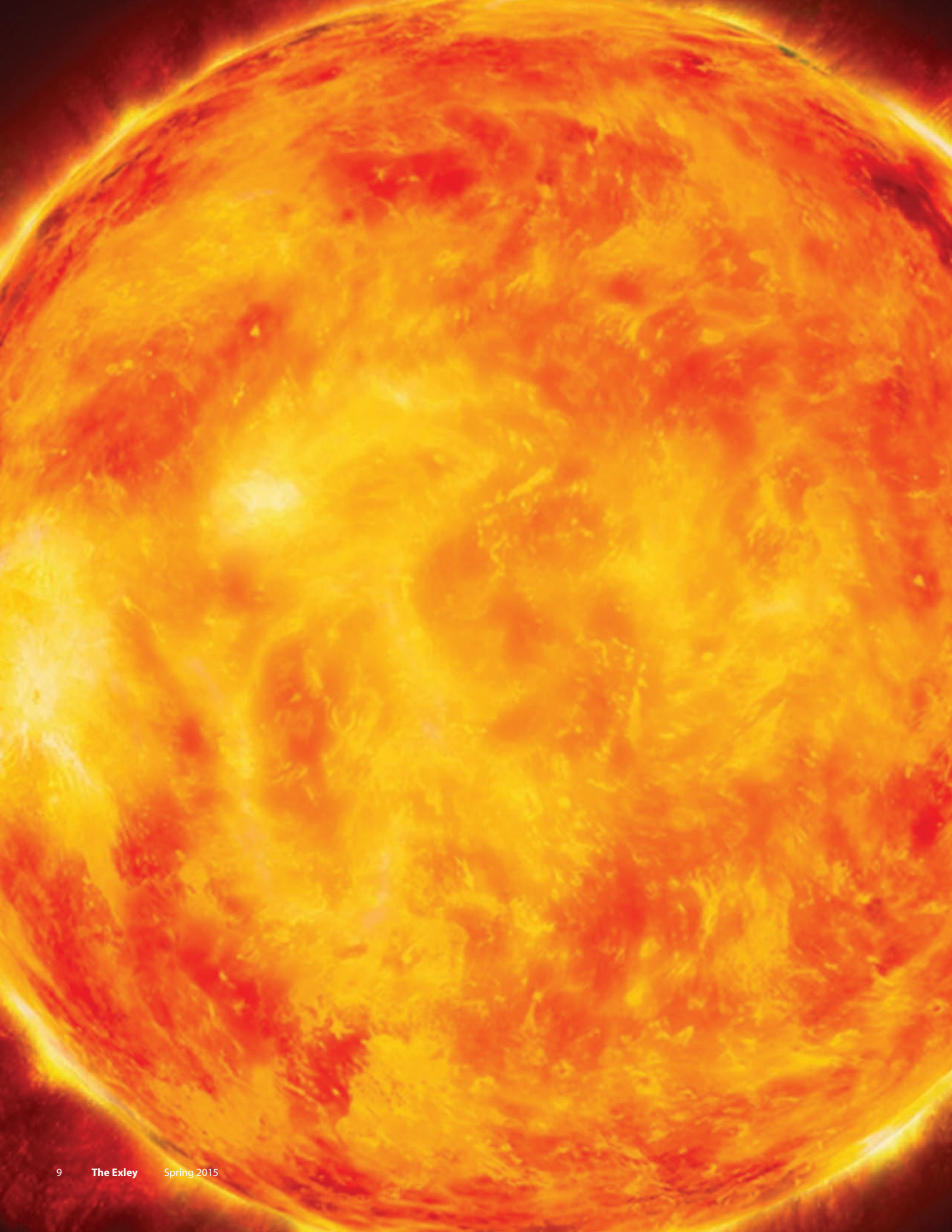
Maireigh Nicholas
Mentor: Sven Kroener
Effects of Chronic Intermittent Ethanol Exposure on Prefrontal Cortex Function Measured in an Attentional Set-Shifting Task

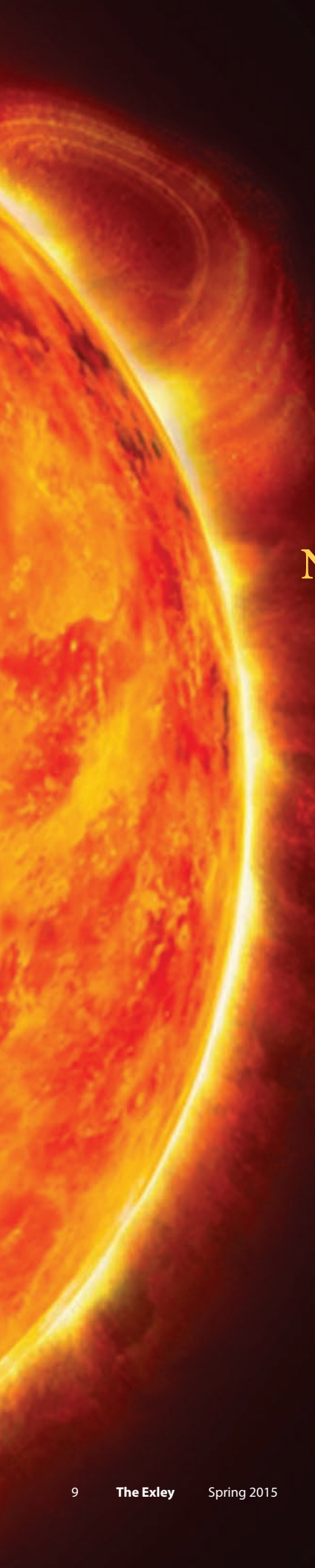
Meera Salamah
Mentor: Kenneth Balkus
Storage and Delivery of Nitric Oxide with Acrylonitrile-Based Balkus Fibers for Wound Healing Applications

Priyanka Shanmugasundaram
Mentor: Michael Kilgard
Optimization of Vagus Nerve Stimulation for the Treatment of Impaired Upper Limb Mobility in a Rat Stroke Model

Tiffany Tran
Mentor: Margaret Owen
The Dallas Preschool Readiness Project

Emma Wentworth
Mentor: Gregg Dieckmann
Studying the Bioadhesion Protein cp52k from Barnacles





Solution Processed Metal Oxide Nanoparticles as Hole Transport Layers in Organic Photovoltaic Devices

Photovoltaic technologies, also known as solar cells, convert the sun's radiant energy into electrical energy. Photovoltaic devices can be used to electrically charge batteries, which are used to power a variety of electronic devices and motors. Currently the most commonly used and manufactured solar cells are inorganic (silicon-based), which may be seen today powering an outside light or camera, or on rooftops. Although solar cells come in many different forms, this research deals specifically with organic (carbon-based) solar cells. Organic photovoltaics (OPVs) offer a more economical approach toward renewable energy generation, and have lightweight, flexible and transparent applications.[1-4] This paper focuses on the advantages of using metal oxides in the fabrication of OPVs. For these advantages to be realized, first a background of photovoltaics needs to be presented.

— by Brandon Adkison

Background

OPVs work by converting incoming sunlight into electrical energy using semiconducting organic materials, such as poly(3-hexylthiophene-2,5-diyl) (P3HT) and [6,6]-Phenyl C61 butyric acid methyl ester (PCBM), shown in Figure 1.

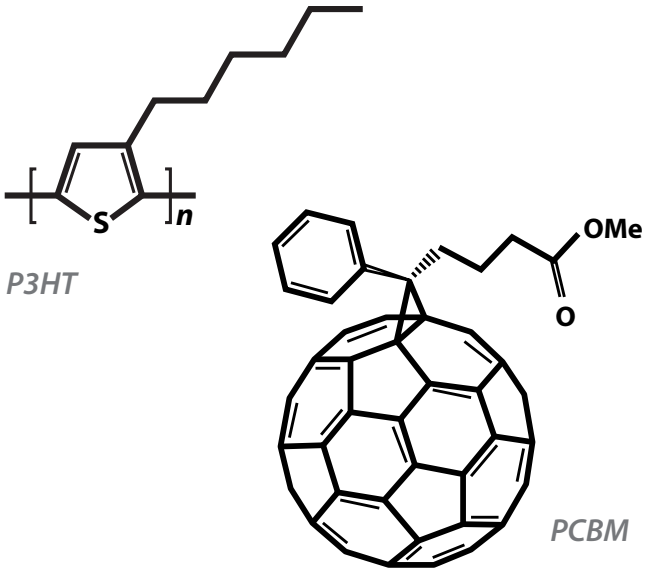


Figure 1: Chemical structures of P3HT and PCBM. Both primarily consist of carbon atoms and have conjugated double bonds.

To generate a flow of electrical energy in OPVs, a light-absorbing component needs to absorb energy from inbound photons provided by the sun. P3HT and PCBM are commonly used together to make up the light-absorbing component (or active layer) in OPVs. This active layer typically contains two materials—an electron donor (for example, P3HT) and an electron acceptor (for example, PCBM)—that are mixed together to form what is called a bulk-heterojunction (BHJ).

In the BHJ, the sun's photons are absorbed in the electron donor material, creating a bound electron-electron hole pair known as an exciton. When excitons diffuse to the donor-acceptor interface of the BHJ, they separate into electrons and electron holes. The electron carries a negative charge (-e). The electron hole (or hole) is simply the lack of an electron at a position where one could be and results in a positive charge (+e). Then, electrons can be collected by a negative electrode and holes can be collected by a positive electrode, creating a flow of electrical energy. The mechanism of sunlight being converted into electrical energy is depicted in Figure 2.

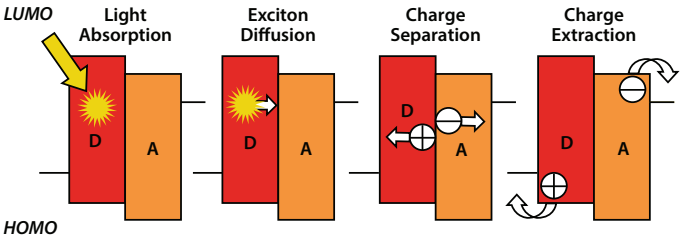


Figure 2: OPV mechanism: Sunlight is absorbed in the electron donor material (P3HT) in the form of an exciton, then diffuses to the interface between the electron donor and acceptor (P3HT and PCMB, respectively) where the excitons are separated into positive and negative charges (electrons and holes) and extracted at opposite electrodes.

The efficiency of OPVs can be significantly improved by depositing transport layers between the BHJ and the electrodes.[5,6] A benefit of transport layers is they can increase the lifetime of OPVs by keeping the air-sensitive active layer unexposed. More importantly, transport layers aid in the transportation of charges from the active layer to the electrodes. They do this by increasing the electrical field between the electrodes. Traditionally, to accomplish this a high work function material known as a hole transport layer (HTL) is placed underneath the active layer to attract holes, and a low work function material known as an electron transport layer (ETL) is applied on top of the active layer to attract electrons.

The work function of a material is the energy of an electron at rest in the vacuum near the surface of the material subtracted by the thermodynamic work required to remove an electron from the material to a state of zero total energy. In other words, the work function is the minimum energy needed to move an electron from a solid material to a point immediately outside that solid surface. This is important because metal oxide nanoparticles (NPs) exhibit very high work function >4.65 eV (electron volts), making them great candidates for HTLs.[5,6] One benefit of metal oxide NPs is that when suspended in a solvent they can be applied as transport layers in OPVs by using a spin coating technique.

This technique allows for thin films to be made without complicated and expensive vacuum equipment and is accomplished by applying a solution on top of a rotating substrate. This paper will discuss the spin coating of thin films of metal oxide nanoparticles (about 1-2nm thick) and examine their performance as HTLs.

Methodology

For the synthesis of metal oxide nanoparticles, molybdenum, tungsten, nickel and cobalt metal powders with average diameter of ~5µm were made into metal oxide nanoparticle suspensions in n-butanol using a modified version of a published recipe.[7,8] A typical reaction that yields 0.1M suspension of metal oxide NPs is made by mixing 0.3mmol metal powder with 525µL n-butanol (Fisher) and 75µL of hydrochloric acid (HCl) (37 percent in H_2O; Fisher), and stirring at 25°C for 20 minutes. 2220µL of n-butanol and 180µL of hydrogen peroxide (H_2O_2) (30 percent in H_2O; Fisher) are additionally added to the solution and stirred at 25°C for 16 hours. This solution is passed through a 0.2µm PTFE syringe filter (Pall) to ensure ultrasmall NPs, and then can be used without further purification (Figure 3).

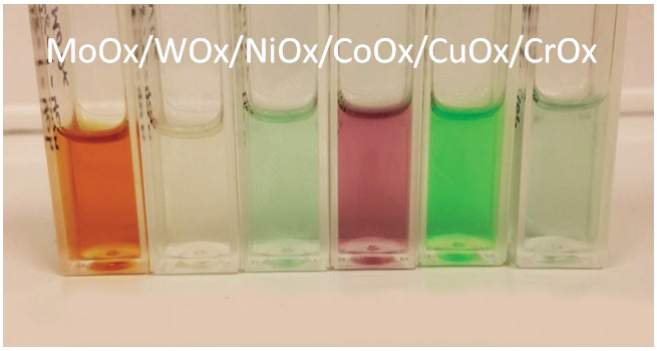


Figure 3: Metal oxide nanoparticles (about 1nm in size) used in this experiment to make hole transport layers; from left, MoOx, WOx, NiOx-, and CoOx NPs.

Metal oxide NP films of different thicknesses were formed by diluting the stock NP suspensions with n-butanol and spin coating four times on top of an ITO (a hole-collecting electrode on top of a glass substrate). (See Figure 4.)

Figure 4: Spin coating machine in which metal oxide NPs were applied at various revolutions per minute when making HTLs.

Following a modified published procedure,[9] conventional OPV devices with the following architecture were fabricated from bottom to top in the following order: ITO/HTL/P3HT:PCBM in chlorobenzene/with calcium/then aluminum evaporated on top (as ETL and top electrode, respectively). Figure 5 shows the general architecture of a conventional OPV device such as this.

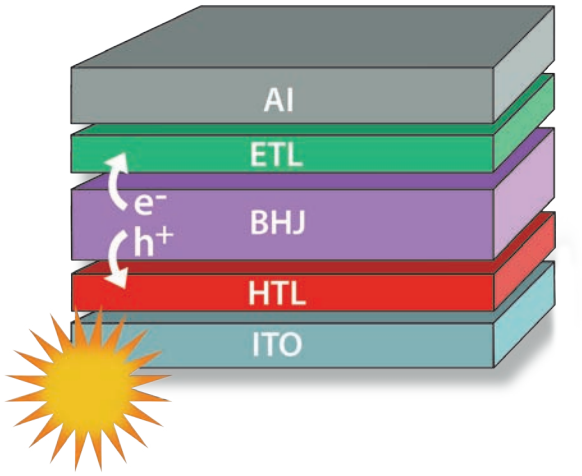


Figure 5: General architecture of a conventional OPV device showing each of the five layers that makes up the organic solar cell. The ITO layer (bottom) is clear and is the first layer the sunlight reaches.

For this experiment, a different HTL was applied to each OPV device, followed by a P3HT:PCBM active layer, then evaporated calcium for the electron transport layer and aluminum for the final electrode. P3HT:PCBM was mixed in ortho-dichlorobenzene (Aldrich) at a ratio of 23:23 mg/mL. Suspensions of 0.0125M MoOx, and 0.00625M WOx, NiOx, and CoOx NPs in n-butanol were spin coated four times at 8000 rpm on top of an ITO substrate to form the HTL, then the work function was measured via Kelvin probe. For reference devices, poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) (Clevios PVP AI 4083, Heraeus) was mixed with isopropanol in a 7:3 volume ratio, spin coated at 4000 rpm on patterned ITO, and annealed in N2 at 170°C for five minutes to form the HTL.

This reference device is commonly used in research as a control and has the same architecture shown in Figure 5. The difference between the control and experimental samples is that the HTL in the control is made from PEDOT:PSS, and in the experimental is made using metal oxide NPs. An additional reference device was made by thermally evaporating (Angstrom Engineering) 10nm of MoO3 on an ITO substrate to form the HTL.

After applying the HTLs, the BHJ active layer is made by dissolving P3HT:PCBM in 23:23 mg/mL of ortho-dichlorobenzene (Aldrich) and spin coating this solution at 1200 rpm on top of the HTL, followed by an in-air processing technique of annealing in N_2 at 170°C for 10 minutes. Finally, the OPV devices are transferred into a vacuum chamber where 7nm of calcium (Ca) and 900nm of aluminum (Al) are thermally evaporated (Angstrom Engineering) to form the electron transport layer and negative electrode, respectively.

Figure 6 shows a completed OPV device made and used for this experiment. The OPV devices were tested with a solar simulator (Abet Technologies) under AM 1.5 100mW/cm^2 illumination (Figure 7).

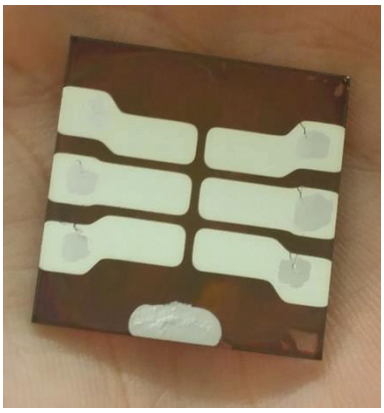


Figure 6: A single organic photovoltaic device with six testable diodes, looking at the top of the negative electrode down through the ETL, BHJ, HTL and ITO.

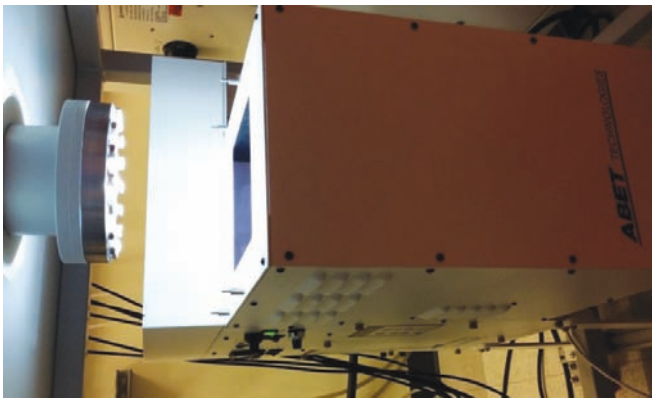


Figure 7: Abet Technologies' solar simulator simulates the intensity and wavelengths of solar radiation.

Discussion

Thin films of metal oxide NPs showed high work function values without the need of any post disposition treatment. P3HT has a work function of 4.65 eV, so the work function of HTLs in organic solar cells made with P3HT:PCBM active layers needs to be greater than 4.65 eV.

When made into thin films, MoOx, WOx, NiOx and CoOx metal oxide NPs display work function values greater than 4.65 eV.[10,11] For example, the work functions of MoOx, WOx, NiOx and CoOx NPs, recorded using a Kelvin probe, were 5.31 eV, 5.36 eV, 5.01 eV and 5.04 eV, respectively, and therefore are good candidates for HTLs.[10,11]

When we compare the performance of OPVs with P3HT:PCBM active layers and metal oxide NP HTLs to the reference OPV containing the commonly used poly(3,4-ethylenedioxythiophene):poly(styrene sulfonate) (PODOT:PSS) as the HTL, we found that the type of metal oxide significantly impacts device performance (Figure 8).

For example, the MoOx HTL device (Figure 8, orange) exhibits lower short circuit density (J_{sc}) compared to the reference device, and lower power conversion efficiency (PCE) of 0.56 percent vs. 3.27 percent (Table 1).

Interestingly, the evaporated MoO3 HTL device (Figure 8, red) also shows a lower J_{sc} and PCE compared to the reference device, although the difference is smaller, implying that compared to WOx, NiOx and CoOx HTLs, devices made with MoOx NP HTL don't perform well when solution processed. Both the NiOx and CoOx NP HTLs made OPVs that performed similarly (Figure 8, blue and purple), with PCEs of 2.65 ± 0.04 percent and 2.68 ± 0.11 percent respectively, and therefore are good materials for making HTLs when solution processed.

The most significant results show that the WOx NP HTL has similar performance compared to the control sample, PEDOT:PSS (Figure 8, green and black), with PCE measured at 3.14 ± 0.07 percent vs. 3.27 ± 0.06 percent respectively. From these results it can be concluded that WOx NPs are the best choice for making HTLs in OPVs.

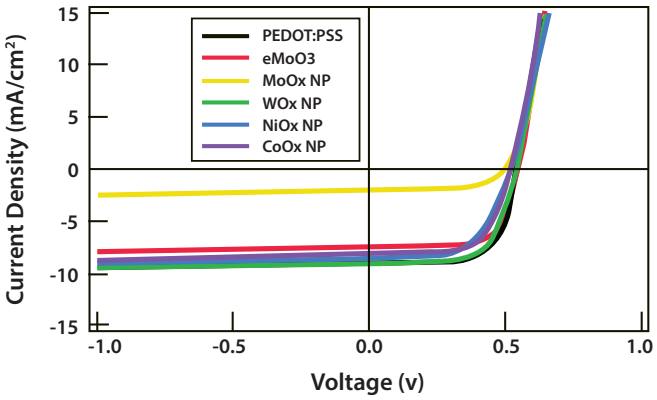


Figure 8: Current density-voltage curves under 100 mW/cm² illumination intensity (1 sun equivalent) for P3HT:PCBM OPVs with HTL of PEDOT:PSS (black), evaporated MoO3 (red), MoOx NP (orange), WOx NP (green), NiOx NP (blue) and CoOx NP (purple).

HTL	V_{oc} (V)	J_{sc} (mA/cm²)	FF ()	PCE (%)
PEDOT:PSS	0.550 ± 0.000	8.95 ± 0.17	0.664 ± 0.006	3.27 ± 0.06
eMoO3	0.545 ± 0.005	7.49 ± 0.25	0.693 ± 0.008	2.83 ± 0.11
MoOx NP	0.487 ± 0.005	1.94 ± 0.07	0.595 ± 0.009	0.56 ± 0.03
WOx NP	0.540 ± 0.000	8.90 ± 0.21	0.653 ± 0.000	3.14 ± 0.07
NiOx NP	0.518 ± 0.004	8.55 ± 0.18	0.598 ± 0.012	2.65 ± 0.04
CoOx NP	0.513 ± 0.006	8.10 ± 0.19	0.644 ± 0.006	2.68 ± 0.11

Table 1: Performance parameters under 100 mW/cm² illumination intensity (1 sun equivalent) for P3HT:PCBM OPVs with different HTLs.

Conclusion

We demonstrated that metal oxide nanoparticles can be used to make good working HTLs in OPVs. We showed that by suspending metal oxide nanoparticles in a solvent they can be applied as HTLs without costly vacuum equipment via spin coating and in-air processing techniques. We also demonstrated how metal oxide nanoparticles make great candidates for HTLs due to their high work function values being greater than 4.65 eV.[10,11]

We experimentally tested and compared the performance of standard PEDOT:PSS HTLs to the performance of several metal oxide HTLs, showing how OPVs with metal oxide HTLs can be made as efficient as standard OPVs. This is important because metal oxide NPs are less expensive, more abundant, more air stable and easier to work with compared to other materials used for HTLs. In conclusion, the results show how WOx NPs can be used to make good performing HTLs, and are therefore the best candidate for making HTLs in OPVs.

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A Serious Game for Cyberbullying Prevention and Education

Research demonstrates that cyberbullying is an issue that clearly needs to be addressed. In 2013, 17 percent of high school students nationwide reported seriously considering suicide and 8 percent reported attempting suicide at least once. During this same year, 14.8 percent of students reported being electronically bullied.[1] Studies have "found a consistent association between being bullied and suicidal thoughts among youth."[2] In order to promote education and awareness of the consequences of electronic bullying, a research-based game titled *Everyone Hates You* was created and published.

— by Carrie Crossley

Background

Cyberbullying is defined as "a systematic abuse of power which occurs through the use of information and communication technologies"[3] and has become increasingly prevalent in middle school and high school demographics over the past few years. Behaviors that constitute cyberbullying commonly include harassment through texting or instant messaging services, online dissemination of sensitive information (such as rumors or nude photographs), and posting hurtful messages on social media sites such as Twitter, Instagram and Facebook.

In a 2012 survey conducted by the *British Journal of Educational Technology*, "84 percent of teachers reported having experienced some kind of cyberbullying, against student victims or themselves."[4] Additionally, "about half the teachers reported that students complain of harassment through the mobile phone and Internet, and some teachers themselves were cyberbullied."[5] These statistics are of notable importance because cyberbullying has severe negative effects on both victims and perpetrators. Additionally, the rising prominence of this online abuse raises a variety of ethical concerns about how we use the Internet.

This project specifically focused on cyberbullying because it is a relatively new ethical issue for which more educational programs are needed. While many traditional anti-bullying programs have adapted to include brief cyberbullying components, "not many intervention programs exist that deal specifically with cyberbullying."[6] Developing programs that specifically address cyberbullying is important because the rise of online abuse is negatively affecting youth worldwide, and research findings "highlight the need ... to design and to plan appropriate actions to prevent cyberbullying, and to implement useful strategies to help pupils in need."[7]

Methodology

Learning Objectives

A game was the chosen method to promote cyberbullying education because this approach allows learners to immerse themselves in a typical cyberbullying situation. By choosing to design the game as a visual novel, game components such as meaningful choices and branching dialogue that allow learners to experience the situation in a variety of different ways were incorporated. This approach felt both unique and intuitive for the target audience because the player has the autonomy to discover the message on their own instead of relying on scare tactics that are typically found in anti-bullying campaigns.

The game is designed to teach the following concepts: what constitutes cyberbullying; how to tell if someone is involved (as a victim or antagonist); potential consequences of cyberbullying to the victims, the perpetrators and bystanders; and how to take appropriate actions if you or someone you know is involved in a cyberbullying situation. The name *Everyone Hates You* was chosen in order to reflect the idea that "because many cyberbullying actions are attempts to publicly humiliate the target or damage her friendships and social status, the self-focus of the imaginary audience may magnify the belief that the entire social world in which the target interacts is aware of her humiliation."[8]

Overview of the Game

Everyone Hates You features branching dialogue and events. Based on their choices during the game, the player experiences one of multiple endings. Over the course of the game, the player interacts with three main characters: Patrick (the bully), Jessica (the victim) and Mrs. Finch (the teacher). Additionally, two secondary characters, Gabe and Lilly, influence the situation. The player herself takes on the role of a bystander, and has various opportunities to help Patrick harass Jessica, encourage Jessica to tell someone, tell Mrs. Finch directly, speak with other students about the online bullying, and take other actions.

The story progresses over the course of a month, where the player observes the other characters during class, then has the opportunity to interact with them in person or through texting and social media. On the first day of school, the player is introduced to Patrick, who is identified as a friend. A few weeks later, Jessica arrives and is introduced to the class as a new student who has moved from a neighboring town. Over the next few days, Patrick is caught multiple times using his cellphone in class, and after school he proudly shows the player what he was up to: bullying Jessica online.

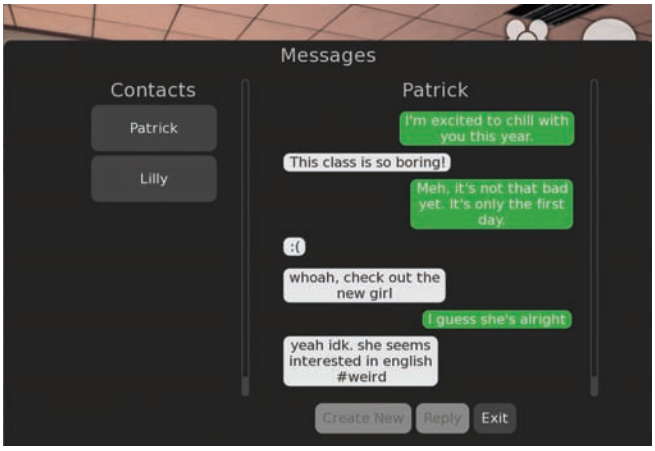
Figure 1: Throughout the game, the player must make a series of choices about how to respond to the cyberbullying situation. The actions they choose have clear consequences for everyone involved.

Patrick is engaging in some typical cyberbullying behaviors by sending hurtful messages to Jessica on MyFace, the in-game social media site. In order to protect his identity and create the illusion that multiple people are involved, he has created multiple fake profiles. After being shown a series of Patrick's hurtful messages, the player is presented with their first major choice: encourage Patrick, discourage Patrick or dismiss the situation. As the game progresses, the choices presented to the player increase in both frequency and severity. The story climaxes at a student club meeting, where the cyberbullying escalates to various forms of physical bullying, depending on the player's choices.

Using Research to Design Characters and Narrative

A significant characteristic of Patrick is that he does not understand the ethical implications of his actions. Throughout the game, Patrick makes multiple remarks that he is "joking" or "just having some fun." This mentality is intended to illustrate to the player that "while students might admit to engaging in certain behaviors online, they might not consider these behaviors to be bullying."[9] Patrick is not aware that his actions are immoral because, like many youth today, he lacks what Andrea Flores describes as "community thinking—an awareness of the potential impacts of online actions ... and reflection on one's roles and responsibilities in online and offline communities."[10] Patrick is influenced to behave this way by his friend Gabe, and Patrick's motives for engaging in this negative behavior align with common motives for bullying that were described in background research: "boredom, ... trying out a new persona or redirecting feelings."[11]

Through Jessica's character, our goal was to illustrate the feelings of hopelessness and depression that are often associated with being a victim of cyberbullying. Over the course of the game, the player has multiple opportunities to interact with Jessica and can treat her negatively or positively both online and in person. Jessica has a difficult time opening up, and often tells the player to "go away" or insists that she is "not worth talking to." Jessica blames herself for the situation because "being victimized may contribute to or magnify a negative view of self, as self-blame is often present in victimized youth."[12] If the player is persistent and kind, Jessica will eventually start to talk about the online threats, and in some cases she can be convinced to tell Mrs. Finch or confront Patrick. However, it takes a significant amount of effort for Jessica to discuss the bullying she is experiencing. This is intended to mirror the fact that in real-life situations, "rather few actually seek help from others; a consistent finding is that if they do tell somebody, their first choice has been to tell a friend ... and lastly a teacher."[13]



Figures 2 and 3: Everyone Hates You places a large focus on electronic interactions. Players can communicate with other characters and influence the story by sending text messages and posting on a social media platform called "MyFace".

As a bystander, the player has the option to be part of the problem or part of the solution. We based this division on our background research:

"Bystanders who are part of the problem are individuals who encourage and support the bully or who watch the bullying from the sidelines but do nothing to help the victim ... bystanders who are part of the solution are individuals who seek to stop the bullying, protest it and provide support to the victim."[14]

The game ends in one of six different ways. Depending on the specific choices made throughout the game, each ending has a varying level of positive and negative consequences. If the player supports Jessica and explains to Patrick why his actions are unethical, they receive the best ending: Patrick takes responsibility for his actions and receives a reasonable punishment, Mrs. Finch praises the player for doing the right thing, and Jessica is able to recover from the experience. The player receives one of a few mediocre endings if he supports Jessica or tells Mrs. Finch about the bullying, but does not attempt to educate Patrick about the morality of his actions. In these endings, Jessica sometimes tells school officials that she is being bullied, a school assembly about cyberbullying is organized, and Patrick is suspended. Depending on the situation, Patrick may or may not understand what he did wrong, and Jessica's success in recovering from the bullying varies.

Negative endings occur if the player chooses to be a bystander who is part of the problem. If the player takes no action to stop the cyberbullying situation, Jessica transfers schools after an attempted suicide, the police get involved in the situation, Gabe is transferred to alternative school, and Patrick faces court charges. In this ending, it is made clear that inaction is not an ethical choice. The player earns the worst ending if they decide to actively help Patrick and Gabe bully Jessica. Similar to the previous ending, Jessica attempts suicide and the police get involved; however, this ending has added repercussions. If the player chooses to engage in the amoral behavior of cyberbullying, everyone involved as an antagonist, including the player herself, faces court charges and is transferred to an alternative school.

While the game's negative endings have severe consequences, it is important to note that we do not attempt to scare the player away from negative actions, and instead present these outcomes in terms of their ethical implications. In either "bad" narrative, Patrick and the player character are shown to express remorse for their actions. Additionally, Jessica's attempt to kill herself is not a scare tactic, but a realistic illustration of the fact that "cyber victimization [is] strongly related to depression, which in turn [is] associated with suicide attempts."[15]

In every ending, we place a particular emphasis on Patrick's understanding of his actions because a successful intervention should focus on more than just punishment. Providing support for bullies and shaping more ethical behaviors is equally important, because in cyberbullying situations, antagonists tend to be at risk as well. Research shows that "students who perpetrate bullying, whether traditional, cyber or both, are at risk for suicidal ideation and/or attempts," and these findings "highlight the importance of programs addressing the needs and behaviors of *both* the bullies *and* the victims."[16] Because this particular facet of cyberbullying is easily overlooked, extra care was necessary to address it in this project.

Results

Several different methods were used to market the game: posting in public areas of the Internet, posting to friends on personal accounts and advertising in person. We linked the game multiple times on Twitter, Facebook, Reddit and Wordpress. For public posts, we used tags such as #stopbullying, #cyberbullying and #gamedev to reach out to users across the world. Between November 21 and December 8, 2013, our Wordpress metrics showed a total of 692 views from 39 different countries. During this time period, we received a total of 82 game downloads and 42 survey responses, with a majority of positive reviews. Since the alpha version was published in April 2014, the game has received a total of 2,920 views from 46 different countries, 553 total downloads and 74 total survey responses.

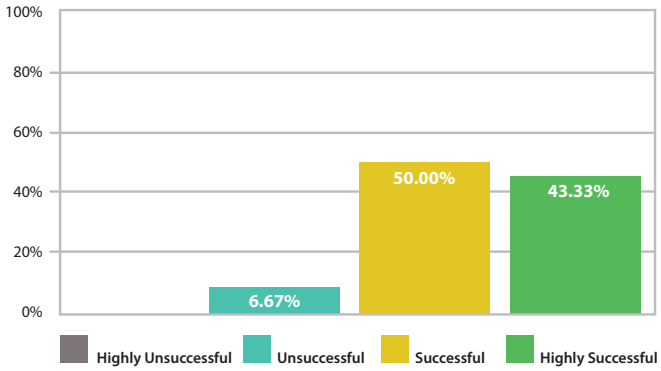


Figure 4: Out of 46 survey participants, 93.33 percent felt that the game was successful in realistically portraying concerns related to cyberbullying.

The majority of survey responses we received were positive: 92.3 percent of participants felt that the game was successful or highly successful at portraying realistic concerns about cyber

bullying. We received some criticism that the game should "provide more options for the character to communicate" and "increase its focus on the MyFace and texting part ... I thought that really brought this to life."

Basing the story, situation and dialogue so closely on research findings made the game highly effective in being immersive and realistic, and eliciting an emotional response. In general, it seemed that a good number of players empathized with the characters. One survey participant appeared to relate to the game on a very personal level:

"I helped Jessica ... I know exactly how it feels to be in her shoes. I personally have had to switch schools and know just how hard that can be. When you are bullied you see everyone against you. You start feeling like everyone is in on it or that no one cares. ... All it took was one person to give me the strength to not care what people around me thought."

Another respondent stated that, "I felt completely awful about bullying Jessica ... especially at the end when she tried to commit suicide. It was a horrifying feeling." These responses illustrate that the message is portrayed accurately regardless of what path the player chooses.

Data from the survey also seems to indicate that *Everyone Hates You* was successful in educating players and promoting discussion about cyberbullying. In regard to learning what to do in a cyberbullying situation, one participant explained that, "My first choices were to try to assess the situation and deal with it myself, but then I learned that wasn't possible so I got an adult involved." Additionally, another participant thought the game "could help potential cyberbullies to understand not just the consequences of their actions, but also at a more basic level realize how insensitive and terrible it is to do that to a person."

Conclusion

Download statistics and survey responses show that *Everyone Hates You* has the potential to make a widespread impact on cyberbullying awareness and education. By creating an immersive, research-based game about cyberbullying, we have succeeded in beginning to educate others about not only the importance of the issue but also how to fight it. With further research specifically targeting implementations in schools, this serious game would likely help to educate teens about the ethical implications of online abuse and begin to reduce cyberbullying behaviors.

Acknowledgments

I would like to give credit to Matthew Benning for writing the dialogue and designing the choice system, as well as to Dr. Matthew Brown and Scott Swearingen, my faculty advisors. All art assets were licensed via Creative Commons and have been appropriately credited in the game. Everyone Hates You is available to download for Windows, Mac and Linux at http://cyberbullygame.wordpress.com.

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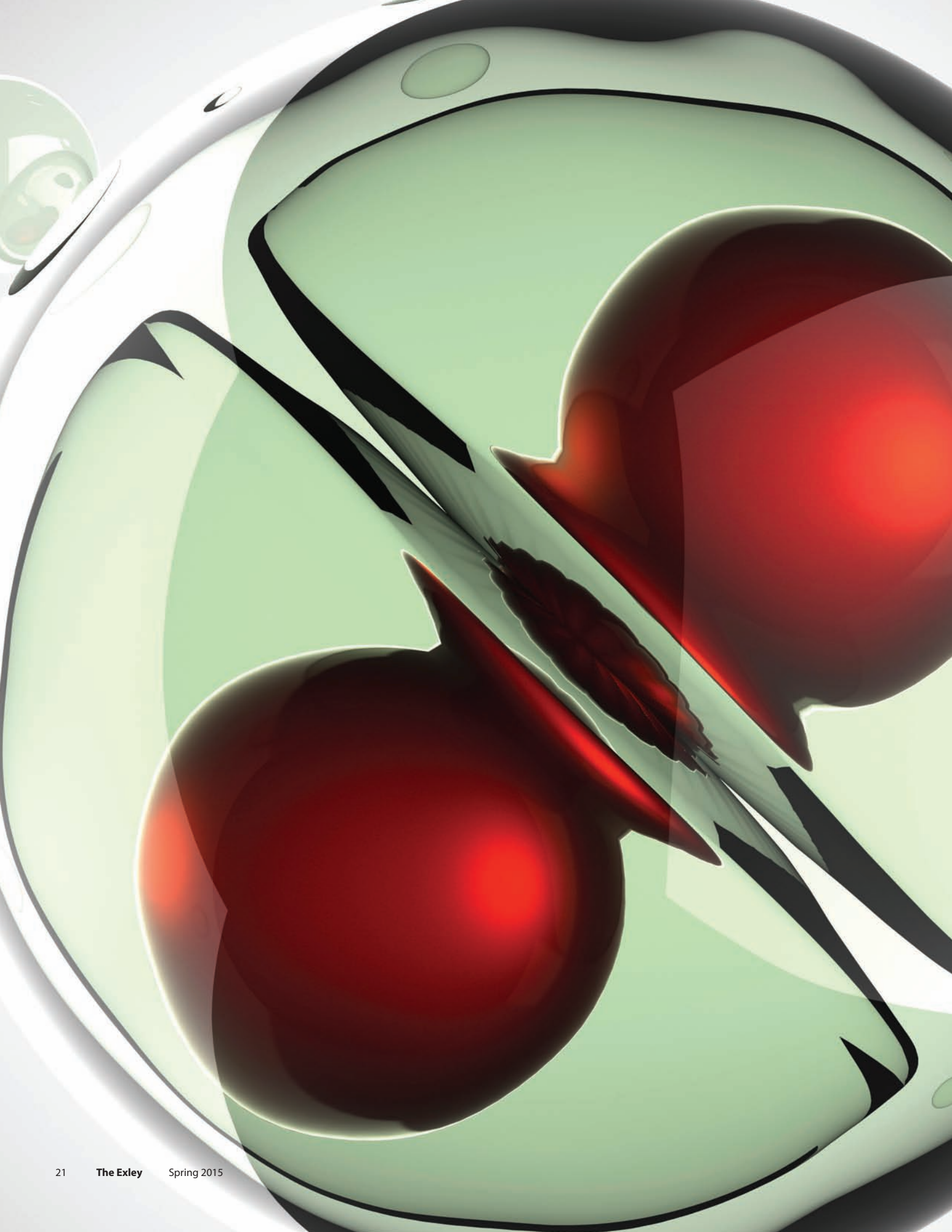

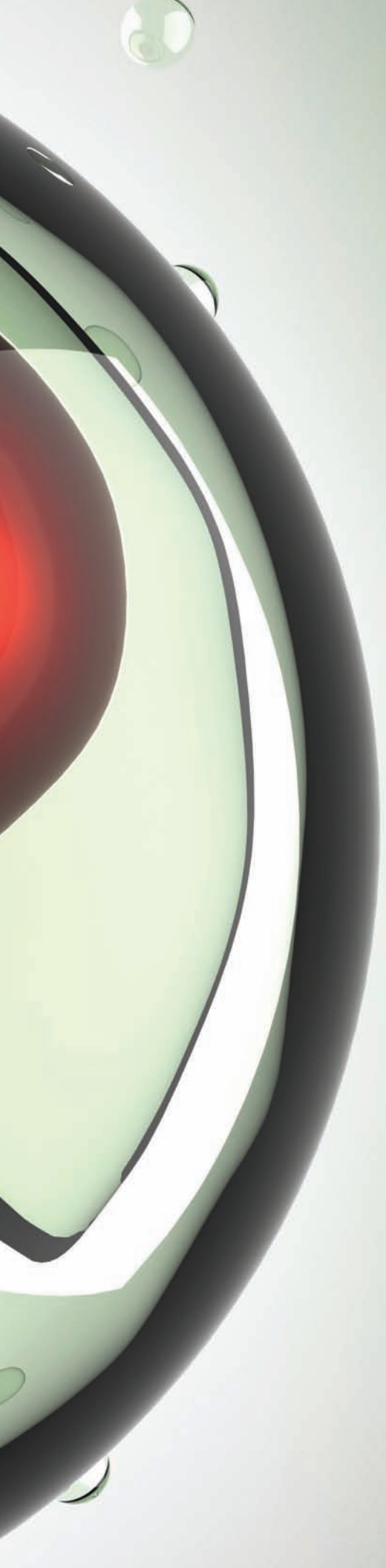

A Biophysical Approach to Studying Microtubule Polymerization Dynamics

Microtubules are essential cytoskeletal polymers composed from subunits of the protein αβ-tubulin.[1,2] Found in all eukaryotic cells, microtubules are integral to many cellular processes, including nerve growth and cell division.[3] Microtubules, as such, are a target for many therapeutics used to treat cancer and diseases involving the nervous system.[4,5] Despite the obvious importance of microtubules, the biochemical mechanisms of polymerization and regulation have not been fully explained. A greater understanding of how microtubules function would aid in the development of new drugs and therapies for a multitude of health issues. This article highlights some of the gaps in our understanding of how microtubules work and outlines some biophysical approaches used to study microtubules.

— by Alexander Burns

Introduction

In most introductory biology or life science courses, students learn about the process of cell division called mitosis. During mitosis, duplicate chromosomes containing the cell's DNA condense and line up in the center of the cell, where each distinct chromosome is pulled to the opposite part of the cell by lines termed spindles.[6] These spindles are actually polymers known as microtubules. Microtubules are hollow, cylindrical polymers made from the protein αβ-tubulin. Each αβ-tubulin is composed of an α and a β subunit, and each binds a molecule of guanosine triphosphate (GTP). The GTP bound by the β subunit can be enzymatically converted into guanosine diphosphate (GDP), a chemical reaction that releases energy. Microtubules are composed of strands of αβ-tubulin, known as "tubulin", associated in a head-to-tail fashion, termed protofilaments.[7] Microtubule behavior is characterized by periods of growing, which abruptly shift to rapid shrinking and vice versa. With sufficient GTP present, individual microtubules will continue to grow and shrink, never reaching an equilibrium length. This curious process observed *in vivo* is termed dynamic instability and is a hallmark of microtubules.[8] Microtubules also exhibit dynamic instability *in vitro* in the absence of the copious proteins found within the cell.

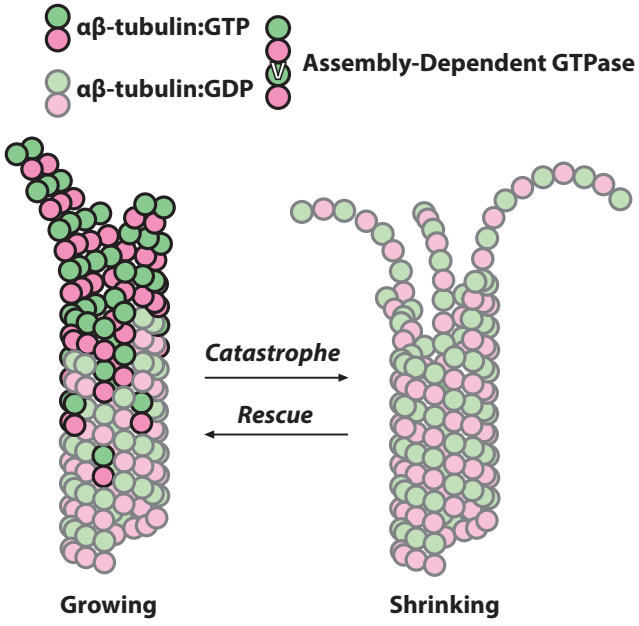

Figure 1: Illustration of microtubule dynamics. Microtubules grow by the addition of GTP-bound tubulin to the microtubule end. GTP can then be converted into GDP when another tubulin molecule is bound on top of it. The switch from growing to shrinking is called catastrophe, and the switch from shrinking to growing is called rescue.

Microtubules grow by the addition of GTP-bound tubulin to the ends of the polymer. Numerous studies have pointed to microtubules consisting of a body of GDP-bound subunits, capped by a small number of GTP-bound subunits.[9] When this stabilizing cap is lost, the microtubule switches from growing to shrinking, in a process known as catastrophe, and quickly depolymerizes. Electron microscopy data shows microtubules growing with sheet-like extensions at the end of a microtubule. When the microtubule catastrophes, its protofilaments split apart and curl back into structures resembling a ram's horn.[10] (Figure 1) This and other evidence have led to the hypothesis that GTP-bound tubulin is "straight," allowing it to be incorporated into the microtubule, while GDP-bound tubulin is "curved," making it unstable in the polymer. However, recent evidence from our laboratory and others points to both GDP- and GTP-bound tubulin monomers existing in a curved conformation. How curved tubulin becomes straight in the microtubule, how and when a tubulin subunit's GTP is converted to GDP, and the size and structure of the GTP-bound tubulin cap necessary to stabilize a microtubule are significant questions addressed through this research.

Methodology and Results

Biophysicists apply the principles of physics and use rigorous mathematical techniques to study biological problems. One aspect of microtubules suitable for biophysical studies is their polymerization dynamics.

Observing Microtubule Dynamics

Microtubule dynamics can be directly observed through microscopy. One form of microscopy our lab uses is video-enhanced differential contrast microscopy (VE-DIC), a form of microscopy that converts gradients in optical path length into images.[11] By taking videos of microtubules and measuring their lengths at several points in time, we can measure growing rates and shrinking rates (Figure 2). We can determine the frequency that microtubules catastrophe, as well as the rate at which they rescue, which is the switch from shrinking to growing.

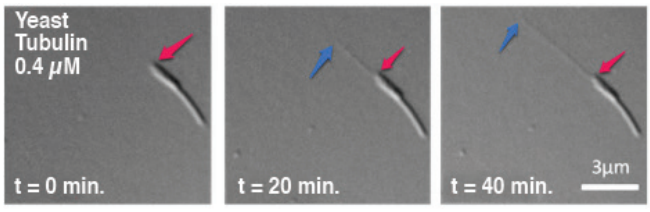

Figure 2: Seeded microtubule growth. This shows a time series of a microtubule (tip shown by blue arrow) grown off of an axoneme (tip shown by red arrow). Axonemes, derived from S. purpuratus (sea urchin) sperm flagella, are a common microtubule seeding agent.

The small-scale biochemical properties of individual tubulins can be understood by studying the large-scale properties of the microtubules they form. For example, it has been shown that there is a linear increase in the growing rates of the microtubules when there is an increase in the concentration of free tubulin in solution.[12] This makes sense, because as there is more tubulin in solution, there is a greater chance of a monomer coming into contact with and adding to the microtubule. By plotting the growing rates of microtubules against the initial concentration of tubulin in a reaction, we can generate an equation that quantitatively describes the growth of microtubules (Figure 3). From this equation, we can obtain the concentration-dependent average rate of tubulin addition to the microtubule and the concentration-independent average rate of tubulin loss—parameters that report on tubulin's affinity for the microtubule.

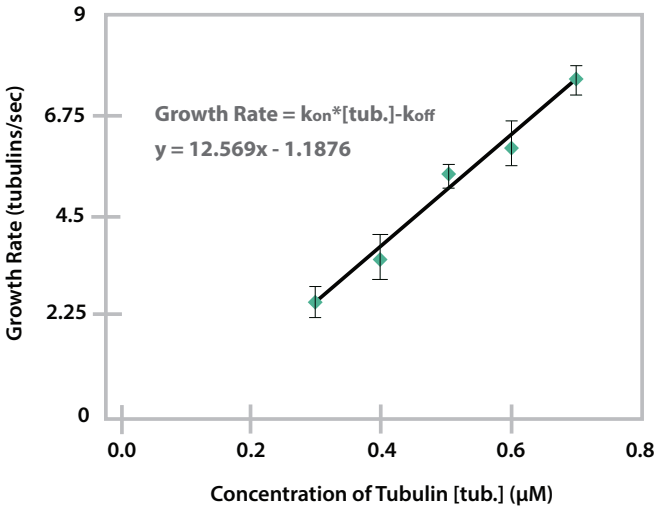

Figure 3: Plot of normal yeast microtubule growing rates vs. concentration of tubulin. k_{on} represents the tubulin concentration-dependent average rate of subunit addition to the microtubule. k_{off} represents the tubulin concentration-independent average rate of subunit loss by the microtubule. The number of subunits is calculated from microtubule length, using the conversion of 1,625 tubulins per micron (μm) of microtubule.

Mutagenesis

Using X-ray crystallography, scientists have worked out the three-dimensional structure of certain conformations of tubulin to atomic resolution. In X-ray crystallography, crystals such as DNA, proteins, or small molecules are exposed to high-energy X-rays. By studying the diffraction patterns these crystals produce, one can determine the location of each atom within the crystal through mathematical analysis. From this structural data on tubulin, we can develop new experiments that probe the functions of tubulin in the microtubule by selecting interesting amino acids (the building blocks of protein) to mutate within tubulin and studying these mutants' behavior.

For instance, consider the crystal structure of tubulin in zinc-induced protofilaments, a structure we believe is close to the "straight" conformation found in the protofilaments of microtubules (Figure 4). One possible approach is to create mutants that might perturb specific properties of tubulin, such as GTP binding or conformation. Observing how these mutants behave in other experiments, such as polymerization dynamic assays, enhances understanding of the function of these amino acids within tubulin, and in the microtubule as a whole.

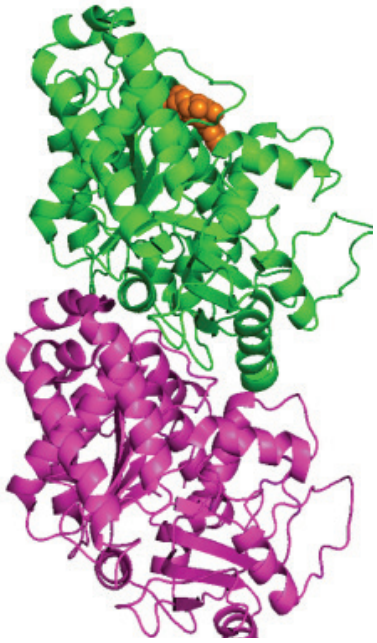

Figure 4: Ribbon diagram of "straight" αβ-tubulin solved by X-ray crystallography. This is the crystal structure of the "straight" conformation of tubulin that we use to help select interesting tubulin mutants to make. α-tubulin is shown in magenta and β-tubulin is shown in green. β-tubulin's bound GTP is shown in orange. (Protein Data Bank:1jff)

To make the mutants, our laboratory has implemented a galactose-inducible yeast overexpression system. First, we transform special yeast cells with plasmids carrying both our gene of interest and specific genes to compensate for metabolic deficiencies in the yeast strain. Plasmids are circular extrachromosomal DNA commonly used in labs for their ability to be easily mutated, purified and inserted into a yeast cell in a process called "transformation." To make αβ-tubulin, we transform host cells with two plasmids—one encoding a gene for either normal or mutant α tubulin, and another encoding a gene for either normal

or mutant β tubulin. We transform a strain of yeast cells, JEL1, that lacks the ability to synthesize the essential nutrients tryptophan and uracil. Each of our plasmids also contains the genes to synthesize either tryptophan or uracil. The result, when transformed properly, is a yeast cell that can produce our two tubulin genes as well as the essential metabolites tryptophan and uracil. We select cells that have been successfully transformed by both plasmids. Because these cells have gained the ability to synthesize these nutrients, they are able to survive on media lacking tryptophan and uracil. This allows only cells that have successfully incorporated these plasmids to proliferate. After allowing our cells to grow and multiply, we induce the expression of our mutant proteins by adding galactose, a simple sugar.

This system of induced expression is preferable because some of the mutants we are interested in studying will kill the cell if expressed throughout its life cycle. Thus, we need a way to regulate the expression of these genes. We do this by using a galactose-inducible promoter in the gene encoding our tubulin. Promoter elements are a region of DNA that precedes a gene and generally contains regulatory proteins that either promote or inhibit transcription in response to the presence of a molecule or protein, which in our case is galactose. After overexpressing our target gene, we harvest the cells that are rich in our protein of interest. The details of the remaining purification are not discussed in this article, but can be found in Johnson.[13] The purified normal or mutant tubulin can be used in a host of *in vitro* experiments that probe microtubule function.

Modeling Microtubule Dynamics

Research in our laboratory focuses on understanding the molecular mechanisms of microtubule dynamics quantitatively. By simulating microtubule dynamics with a computational model, we can test and refine possible mechanisms that govern dynamic instability. If we are correct in the assumptions we input into the model, then we should be able to recapitulate experimentally derived data.

Our laboratory uses a Monte Carlo–style model, similar to that described by Odde, et al.[14] In Monte Carlo simulations, events such as tubulin addition or loss, or GTP to GDP conversion, occur at an average, exponentially distributed rate. Our model generates a random number between zero and one for each possible event, and from this number and the bulk average rate this event occurs (Figure 5a), the model assigns the time it will take this particular instance of the event to occur. From this list of times, the computer then selects the event that would take the shortest time to complete and carries out this event. It then updates the state of the model and repeats the whole process. Thus, microtubule dynamics can be simulated one event at a time.

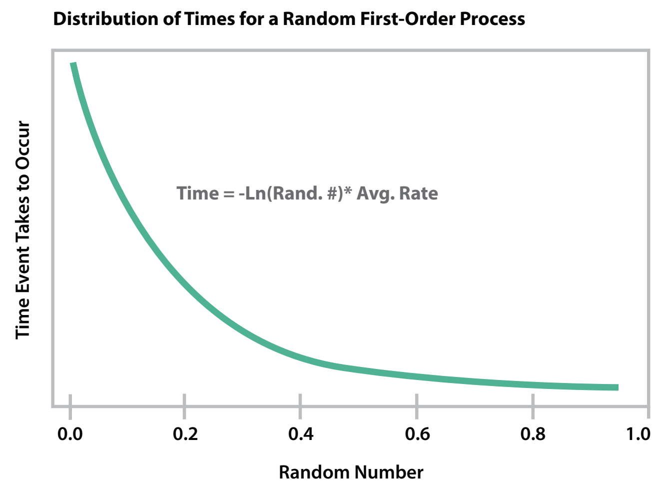

Figure 5a: An event in a Monte Carlo simulation will on average occur at a specified rate. The possible times an event can take to occur are exponentially distributed around the average time. The distribution of these times can be represented as a first-order process, whose equation is given. In our Monte Carlo simulation, we use this distribution to generate a random time it will take for a first-order event to occur.

Lattice State

0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	1	1	0
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1	1	1	1	1	1	1	1	1	1	1	−1	1
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1	−1	1	−1	−1	1	1	1	−1	−1	1	1	1
−1	−1	−1	1	−1	1	−1	−1	1	−1	1	−1	1
−1	1	1	1	−1	−1	1	1	1	−1	1	−1	1
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1	−1	1	1	−1	1	1	−1	1	−1	1	1	1
−1	−1	−1	1	−1	−1	−1	−1	1	−1	−1	1	1
1	−1	−1	1	1	1	1	1	−1	1	−1	1	−1
−1	−1	−1	−1	−1	−1	−1	−1	1	−1	1	−1	1
1	1	1	−1	−1	−1	−1	−1	−1	−1	−1	1	1

Figure 5b: End of simulated microtubule. 1 represents a GTP-bound tubulin, -1 represents a GDP-bound tubulin, and 0 represents an empty spot within the matrix.

Our model represents a cylindrical microtubule as a two-dimensional matrix of numbers (Figure 5b). 1 represents GTP-bound tubulin and -1 represents GDP-bound tubulin. GTP- and GDP-bound tubulin each have different affinities for the microtubule, and these along with other parameters can be adjusted within our model to better represent experimental data. This current model is imperfect in that the frequency of catastrophe for our simulated microtubules is too sensitive to the concentration of tubulin. If we tune our parameters to re-create the correct frequency of catastrophe for one concentration of tubulin, then microtubules made at a higher concentration of tubulin hardly ever catastrophe, and those made at a lower concentration never grow. Though our model is not perfect, we can still extract useful knowledge from its shortcomings. These shortcomings highlight the gaps in our understanding and guide us in designing experiments to test new hypotheses. Our experimental data influences our model, and our model influences our physical experiments.

Conclusion

After half a century of intense study, there are still major questions that need to be answered in the microtubule field, such as how tubulin's conformational cycle contributes to microtubule dynamics. By understanding these fundamental processes, we will be able to develop better therapeutics for the treatment of many diseases, including cancer and many nerve disorders. In an effort to understand microtubule function, most studies up to this point have used mammalian tubulin, such as that from cows, since it is more similar to human tubulin. A major drawback to this approach is that it is not yet possible to obtain recombinant αβ-tubulin from these organisms. Our laboratory uses a galactose-inducible overexpression system in yeast to obtain large quantities of mutant tubulin, allowing us to run novel experiments to probe microtubule function. These biochemical studies, in conjunction with our computational studies, will allow us to gain insight into this fundamental biological phenomenon of dynamic instability.

Acknowledgment

The clinical research for this submission was conducted in the laboratory of Dr. Luke J. Rice, Assistant Professor at the University of Texas Southwestern Medical Center.

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Fear Extinction in an Animal Model of PTSD via Vagus Nerve Stimulation

Post-traumatic stress disorder (PTSD) is a trauma-based stress disorder that affects individuals even when the original stressor is not present. In humans, a characteristic of PTSD is failure to extinguish an emotionally arousing cue. PTSD is prevalent among—but not limited to—abuse and war victims, with about 5.2 million Americans ages 18 to 54 affected per year, according to the U.S. Department of Veterans Affairs.[1] Victims of child sexual abuse, physical assaults, and disasters or accidents, and witnesses to death or injury are also prone to trauma, which leads to PTSD in approximately 7 to 8 percent of the U.S. population. PTSD patients have impaired fear extinction, as they are unable to reduce their anxiety response to reminders of the trauma over time.[2]

Currently, no viable cure for PTSD exists; however, exposure therapy decreases distress by changing the way PTSD patients react to stressful memories.[3] During exposure therapy, patients are exposed to the stimulus they find threatening until they learn that the stimulus should no longer be interpreted as threatening. Unfortunately, this therapy does not work for everyone, as nonresponse and dropout rates are approximately 50 percent.[4] An adjunct treatment to exposure therapy would be beneficial in these nonresponsive patients. An optimal adjunct would enhance new memories while being anxiety reducing to combat the emotional response experienced during exposure therapy and enhance extinction of the conditioned fear.

— by Simran Malhotra

Background

Vagus nerve stimulation (VNS) is a Food and Drug Administration–approved treatment for epilepsy and treatment-resistant depression. The vagus nerve is the 10th cranial nerve in the body and projects into the medulla oblongata in the brain stem, which controls various involuntary functions—such as breathing and heart function—to create a parasympathetic response. In addition, the vagus nerve receives sensory information of the body organs to the central nervous system. VNS creates a parasympathetic response in the body and could be a beneficial adjunct to exposure therapy because it possesses the unique effects of being anxiolytic—anxiety inhibiting—and memory enhancing. Our lab has shown that VNS can enhance extinction of conditioned fear in rats, which is impaired in individuals with PTSD. In addition, our lab has shown that VNS can reduce anxiety when administered acutely. However, the effects of VNS in a population of animals with PTSD symptoms are not known.

Materials and Methods

This research examined the effects of VNS on fear extinction in an animal model of PTSD, called the single prolonged stressor (SPS) model. This model exhibited impaired fear extinction in rats, similar to the impairment seen in PTSD patients.[5] The experiments performed on these animals followed the guidelines set by the Institutional Animal Care and Use Committee. Rats were divided into four groups: SPS-subjected with VNS (SPS-VNS), SPS-subjected with sham stimulation (SPS-Sham), controls not subjected to SPS with VNS (C-VNS), and controls not subjected to SPS with sham stimulation (C-Sham).

All rats underwent surgery to implant a cuff made out of biocompatible micro-renathane around the vagus nerve. This provided electrical stimulation of the vagus nerve when a current ran through it. Sham animals still underwent surgery. Though no cuff was implanted, the vagus nerve was isolated for control purposes. The rats were given one week to recover from their surgeries before SPS exposure began. The C-Sham and C-VNS groups were not subjected to SPS. As part of the SPS protocol, the SPS-VNS and SPS-Sham groups were subjected to two hours of immobilization, followed by 20 minutes of forced swimming. The rats were given 15 minutes to recover and then received ether stress until loss of consciousness.

All animals underwent a fear conditioning and fear extinction protocol to assess the ability of VNS to enhance fear extinction in an animal model of PTSD. We hypothesized that SPS-Sham animals would be resistant to fear extinction, but that SPS-VNS animals would successfully extinguish their fear to control levels.

Fear response was tested in controlled foot shock boxes. Figure 1 shows a timeline illustrating the behavior protocol. The rats were placed in the boxes, where tones played for 30 seconds at a time and a foot shock of 0.4 mA was administered sometime during the tone. A total of eight 30-second tones—all paired with singular foot shocks—were played with variable rest periods in between. After two days of foot shocks, a conditioned fear response test (CFRT) was performed on the third day in the absence of foot shocks but with the persistence of tones. CFRT days were recorded to show the rats' responses to fear conditioning and whether they could properly extinguish the fear of the tone without foot shocks. The behavior was recorded with a webcam for all four tones and freezing time was scored.

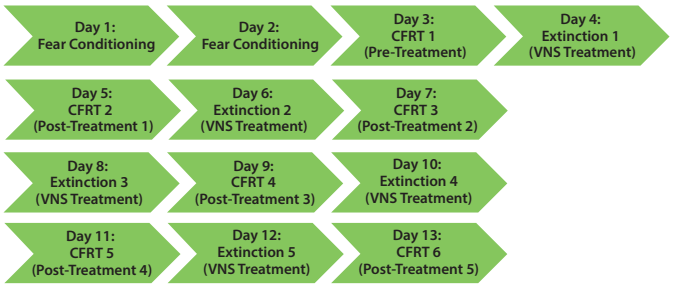

Figure 1: Timelines for fear conditioning days, CFRT days and extinction days. The first two days of the behavior protocol are fear conditioning days followed by repeats of CFRT days and extinction days. The first CFRT day (Day 3 of the behavior protocol) is considered the "pre-treatment day" since no VNS was administered prior to that day. The CFRT days following that are considered "post-treatment days" since the extinction days before them had VNS administration.

Time spent freezing was recorded as the measure of fear. Freezing was defined as the cessation of movement, aside from breathing. An extinction trial followed the CFRT day, and VNS was administered at 0.4 mA for 30 seconds to the SPS-VNS and C-VNS groups as the tone played. Freezing time was not recorded during extinction days since we were unsure of the effects of VNS on behavior. A reduction of freezing time indicated greater fear extinction. There were a total of six CFRTs and five fear extinction training days, and freezing time was predicted to decrease gradually in the C-Sham, C-VNS and SPS-VNS groups after each CFRT.

Results

C-Sham, C-VNS and SPS-VNS animals all showed a significant decrease in freezing time during the 13-day behavior protocol. However, SPS-Sham rats did not exhibit as great of a freezing time reduction as the rest of the groups, as shown in Figure 2. Because SPS-VNS rats were exposed to VNS every fear extinction day along with the mock exposure therapy, their freezing times decreased to a level similar to the control groups. However, SPS-Sham rats did not receive VNS, and thus exhibited impaired fear extinction.

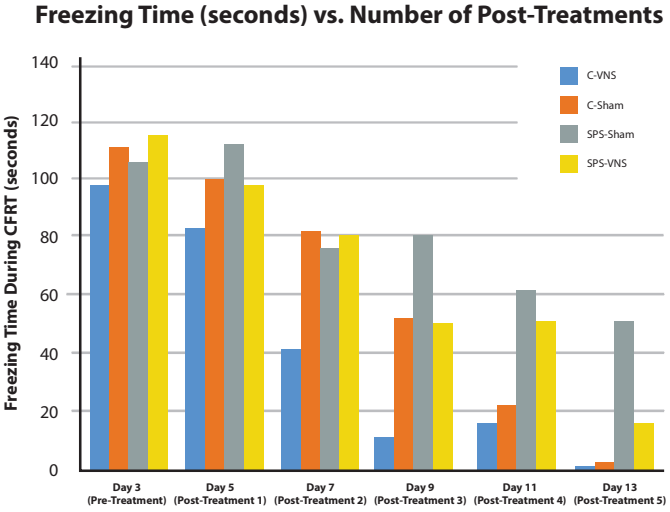

Figure 2: VNS enhances fear extinction in animals subjected to SPS. The data represents averages of each group of rats. A total of 12 rats were used in this cohort, divided evenly into three rats per group. The freezing time on the y-axis is a measure of fear, recorded post-VNS treatment. The x-axis represents the CFRT days. The first CFRT day is pre-treatment since no VNS was administered. All of the following CFRTs are considered post-treatments since the rats received VNS administration the day before each CFRT.

These results demonstrate that, when paired with fear extinction in an animal model of PTSD that is resistant to extinction, VNS facilitates successful extinction.

Conclusion

The SPS animal model for PTSD has shown impairments in extinction of conditioned fear. The animal model tests potential effects of VNS on a population that is resistant to fear extinction. With the addition of VNS, SPS rats showed significant reduction in freezing time while paired with extinction training, compared to the SPS rats that did not receive VNS. This research demonstrated the potential for VNS to be used as an adjunct to exposure therapy in PTSD patients to help extinguish maladaptive fear responses.

Spontaneous recovery will also be tested in our research lab one week after completing all the CFRTs and fear extinction trials. Spontaneous recovery will be similar to CFRT days, where tones will be played without foot shocks. It is expected that VNS-treated rats will show a smaller freezing time percentage versus sham-treated animals. If VNS-treated animals are resistant to spontaneous recovery, it supports the idea of VNS being a useful adjunct to exposure therapy in patients suffering from PTSD.

Using vagus nerve stimulation as an adjunct to exposure therapy with PTSD patients will allow for a decrease of nonresponsive patients. Extinguishing fear response in triggering—but safe—environments will improve the quality of life for individuals with treatment-resistant trauma.

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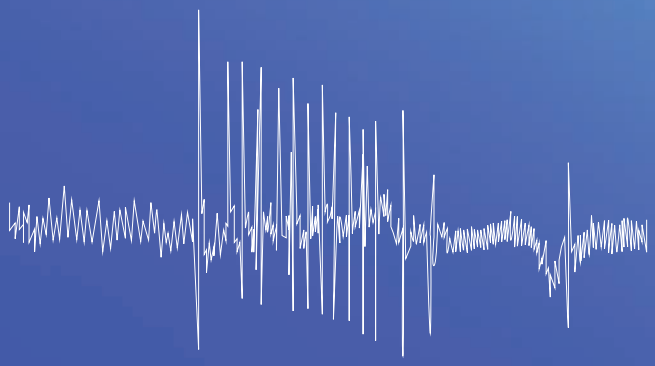

Bleomycin-Induced Lung Injury Enhances Cough Responsiveness

Idiopathic pulmonary fibrosis (IPF) is a progressive and fatal disease characterized by scarring of the connective tissues in the lung.[1] Gastroesophageal reflux disease (GERD) is a commonly reported comorbidity in patients with IPF and it has been suggested that IPF may result from chronic microaspiration of refluxate.[2] A persistent dry cough accompanies both IPF and GERD, adversely impacting quality of life.[3] We hypothesize that repetitive airway surface liquid acidification both initiates and hastens the development of pulmonary fibrosis and enhances cough responsiveness.[4] We further hypothesize that the mechanical strains associated with persistent coughing promote further fibrosis and accelerate lung function decline.

— by Aaron Dotson

Introduction

To begin to address these hypotheses, we have developed a bleomycin-induced lung injury model in subjects and evaluated cough responsiveness over the course of five weeks following initial challenges.[5] Subjects received either saline injections (n = 14) or bleomycin (4U/kg) injections (n = 14), with both injections performed under brief ketamine/xylazine anesthesia. Body weights and respiratory rates were measured weekly, and cough responses to citric acid (0.01-0.3M delivered as an aerosol) were evaluated weekly in eight animals per treatment group. Cough responsiveness was markedly increased in the animals receiving bleomycin, with four of eight bleomycin-treated subjects. Only one of eight control subjects coughed 15 or more times to the citric acid challenge. Overall, citric acid evoked 11±1 and 17±3 coughs on average over the course of three weeks following intratracheal saline or bleomycin injection, respectively (n = 8 per treatment group; $p<0.05$). Body weights and respiratory rates were not different between the treatment groups, suggesting a modest lung injury despite the marked change in cough responses. We speculate that this novel model of lung injury will facilitate studies of the relationships between pulmonary fibrosis, reflux and cough, and perhaps lead to more rational and effective treatments for IPF.

Hypothesis

We hypothesize that pulmonary fibrosis enhances cough reflex sensitivity.[6] We further hypothesize that repetitive airway surface liquid acidification evokes coughing and hastens the development of pulmonary fibrosis, and that variations in weight and respiratory rates of individuals subjected to respiratory injuries via pulmonary fibrosis will ensue. Finally, speculation that coughing, through mechanical strain on the lung, perpetuates airway remodeling and adversely impacts outcomes in pulmonary fibrosis was tested.[7]

Methods

A six-week study was conducted involving 28 pathogen-free male Hartley strain guinea pigs with an average body weight of 255 grams. Guinea pigs were used for this experiment because they have a cough response capable of recording. The methods are as follows:

Handling

Human handling for three days prior to surgery and experimentation allowed the animal subjects to become comfortable with human interaction, ultimately reducing anxiety and variability in results. Prior to surgery, subjects were marked to distinguish control animals from test animals. Subjects were handled and re-marked post-surgery, allowing for further animal habituation to human interaction.

Tracheal Surgery

All subjects underwent surgery during brief ketamine/xylazine anesthesia to permit either saline (14 subjects) or bleomycin (14 subjects) injections. Afterward, the following injections were prepared: 4U/kg of saline (n = 14) and 4U/kg of bleomycin (n = 14). Injections were administered during subject inhalation to ensure maximal drug/saline intake. The subjects were then allowed to rest in a clean, heated space until regaining full consciousness.

Post-Operational Procedures and Respiratory Vitals

Each week following the surgery, all animals were weighed and their respiratory rates recorded using a plethysmograph while in an exposure chamber. The plethysmograph is used to monitor pressure changes while animals are in the exposure chamber. The rhythmic cycles of respiration were noted as sinusoidal waves via the plethysmograph computer software. Baseline respiratory rates were logged after five minutes of recording. Following recordings, an average respiratory rate was calculated via the plethysmograph program. Baseline respiratory rate checks also allowed for animal habituation while in the exposure chamber, prior to citric acid experimental testing.

Progressive Citric Acid Cough Challenges

Two weeks following the surgery and each week subsequently, eight subjects in each treatment group underwent citric acid cough challenges. Citric acid in progressive concentrations (0.01-0.3M) was delivered to the recording chamber via a nebulizer, with cough responses recorded by monitoring pressure changes in the exposure chamber via the plethysmograph and adjunct software. Animals were placed in the exposure chamber, and their baseline respiratory rate recorded for five minutes. Progressive citric acid cough challenges followed, proceeding sequentially by increasing molar concentrations. The citric acid/saline solutions were 0.01M, 0.1M, and 0.3M. Each nebulized citric acid challenge lasted five minutes. Coughs from the subjects were visually observed through the exposure chamber, as well as graphically by sharp deflections upon the plethysmograph computer program. If subjects expressed signs of respiratory distress, such as prolonged breathing and lethargy, the citric acid challenges concluded.

Results

Intratracheal bleomycin administration acutely (one to two weeks) increased the responsiveness to cough challenges with citric acid. The effects of bleomycin were short-lived, resolving within four weeks of initial insult and not accompanied by alterations in either weight gain or respiratory rate. Analysis of animal body weight and respiratory rates

following intratracheal treatment surgeries and prior to citric acid cough challenges showed small variances, particularly in respiratory rates, but no significant changes (Figure 1).

Bleomycin Treatment Did Not Alter Weight Gain or Respiratory Rate in Guinea Pigs

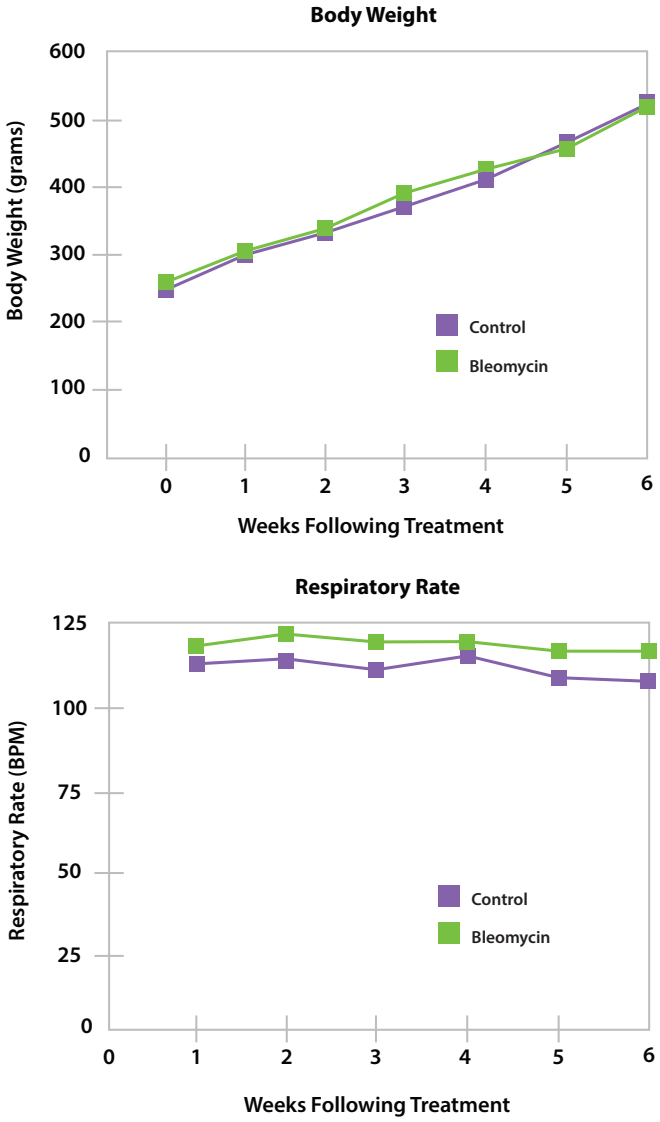

Figure 1a: Graph of body weight shows a clear linear relationship over the six-week period of experimentation. No significant changes in body weight were observed.

Figure 1b: A small variance in respiratory rate was observed between bleomycin-treated and control subjects, but the difference was not significant.

Overall, citric acid evoked 11±1 and 17±3 coughs on average over the course of three weeks following intratracheal saline or bleomycin injection, respectively (n = 8 per treatment group; $p<0.05$). Bleomycin-treated animals showed significant distinction from the saline-injected subjects through the high yield number of coughs. During the first two weeks of citric acid challenge, 50 percent of bleomycin-treated animals coughed 15 or more times, whereas 0 percent of the saline-injected subjects were able to achieve such a number (Figure 2).

Citric Acid—Evoked Coughing is Enhanced Following Bleomycin-Induced Lung Injury

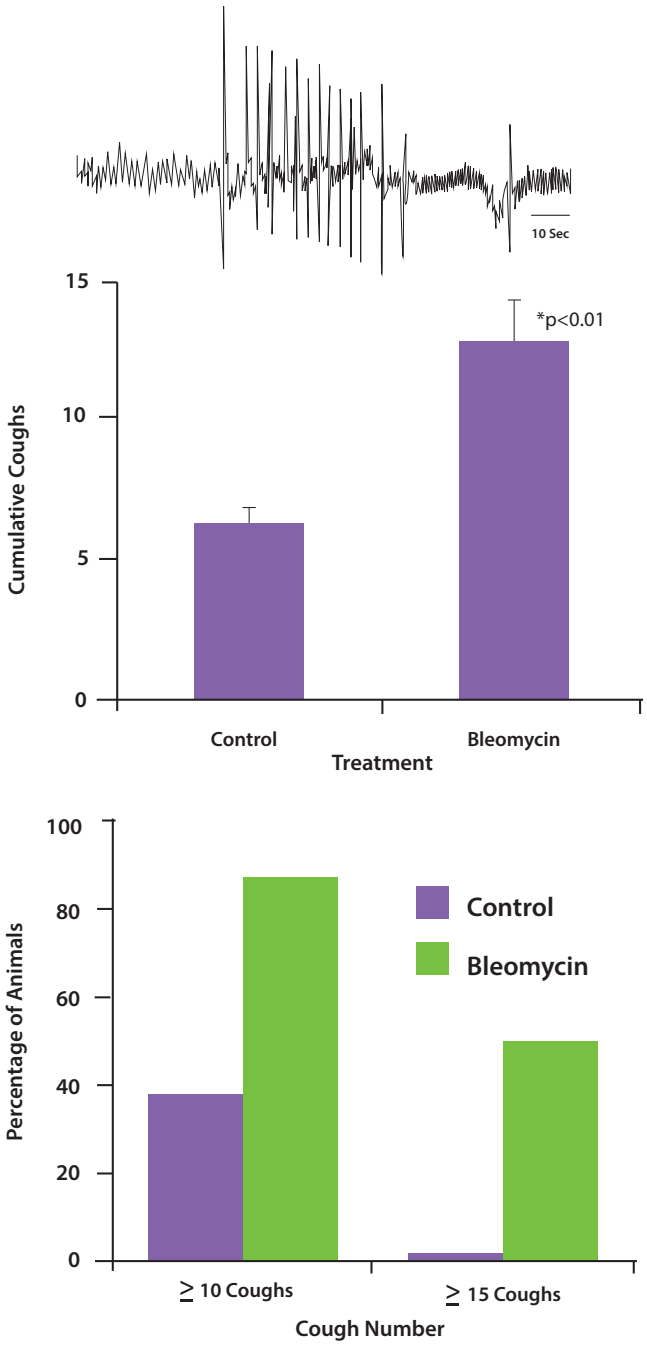

Figure 2: Results from the first two weeks of cough challenge following bleomycin or saline treatment.

Repetitive citric acid challenges over the course of four weeks did not enhance cough responsiveness in control animals or in animals treated with bleomycin. Analysis showed after four weeks of challenges, the number of coughs on average were 8±2 and 11±4 for control and bleomycin-treated subjects (Figure 3). Tracheal and lung tissue staining was performed following experimentation to verify the occurrence of acute lung injury.[8] Hence, the results are consistent with a mild acute lung injury that resolves within several weeks of initial insult.

Bleomycin-Induced Enhancement of Cough Responsiveness is Not Sustained

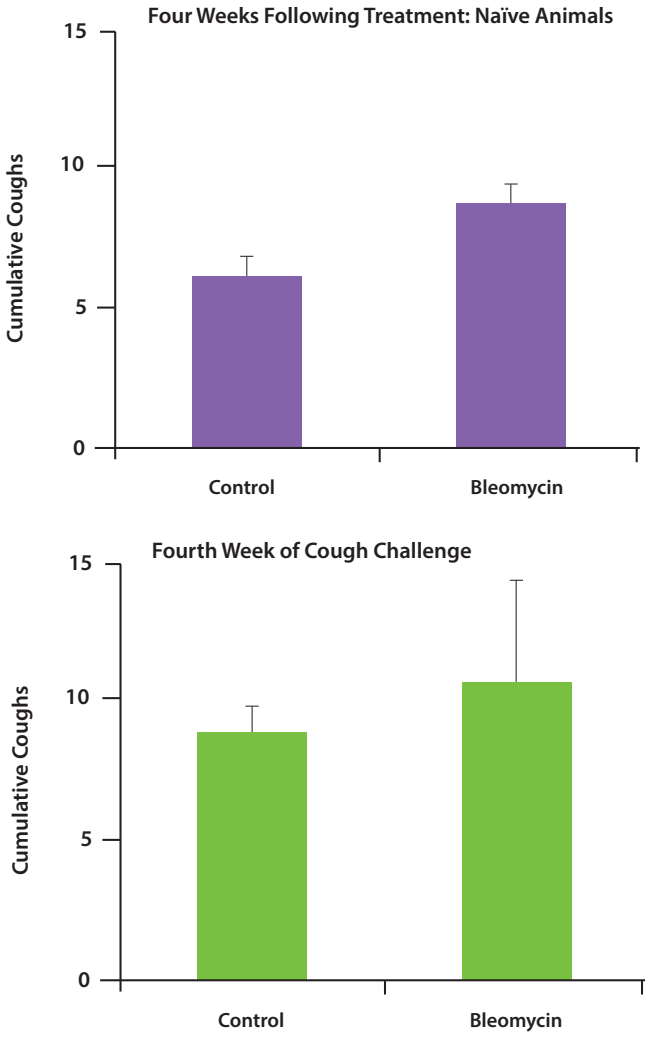

Figure 3: While there was a numerical difference in number of coughs when comparing naïve and cough challenge subjects, the results were not of great significance. This observation illustrates the possible occurrence of a mild acute lung injury at the beginning of experimentation, followed by progressive recovery.

Observations made during tracheal surgery gave insight to intratracheal irritation of the respiratory tract with the administration of bleomycin, but not with saline. When administered acutely, bleomycin caused marked respiratory slowing and occasionally apneas, whereas saline showed no significant effect. Intratracheal saline injections evoked transient changes in respiration that quickly resolved and typically involved transient increases in respiratory rate. Bleomycin evoked long-lasting decreases in respiratory rate, comparable but smaller in magnitude to the effects of bronchopulmonary C-fiber activation, typified here by intratracheal capsaicin administration (Figure 4).[9]

This suggests that bleomycin may be acutely irritating to the respiratory system via specific channel innervation. We are in the process of evaluating the hypothesis that bleomycin indirectly activates bronchopulmonary C-fibers through activation of the reactive oxygen species-sensitive ion channel TRPA1. Future experimentation, utilizing the same surgical protocol, with additional subjects, followed by bronchial cell culture colonization, will help to study the hypothesis.

Bleomycin is Acutely Irritating Upon Intratracheal Administration

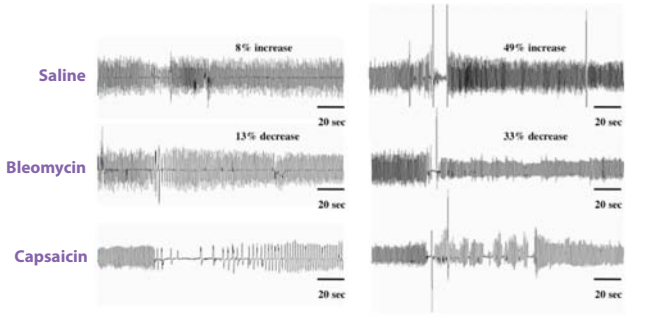

Figure 4: Illustrates the representative traces of respiratory rates from two subjects utilizing plethysmograph recordings.

Conclusion

The summed data, results and analysis suggest that bleomycin-induced lung injury may enhance cough responsiveness to citric acid. These effects of bleomycin are short-lived, however. This is consistent with an acute and mild lung injury that resolves within weeks of initial insult. Bleomycin treatment also is not accompanied by alterations in weight gain or respiratory rate. Future testing will involve a higher dosage of intratracheal bleomycin injections.

For this experiment, 4U/kg bleomycin was used for injections. There is the possibility that this dose was too low to cause a long-lasting lung injury. By increasing the dose in future experiments, a prolonged respiratory injury might be more probable, rather than a short-lived acute lung injury.

Future testing will also involve citric acid challenges of greater concentrations while keeping the well-being of the animal in mind. Nevertheless, this preliminary data encourages further attempts at modeling fibrosis in subjects with the goal of evaluating the accompanying changes in cough responsiveness and the effects of repetitive airway surface liquid acidification on the progression of fibrotic disease of the lungs.

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About the Creative Contributors

Matthew T. Rader is a senior emerging media and communication major originally from San Diego, California. Before coming to UT Dallas, Matthew traveled throughout the United States and the world. He has visited over 40 U.S. states, Canada, Curaçao, Australia and India, lived in South Korea for a year and a half, and spent 4½ years living in southern Mexico. Through his travels, he discovered a love of photography and visual storytelling. A common thread he observed across all cultures is two people joining in marriage to create new families. As a result, Matthew's goal is to become an established wedding photographer. You can connect with him on Twitter and Instagram @Matthew_T_Rader.

Khadijah Mazhar is a sophomore Collegium V Honors student, majoring in biology. She is currently researching the neurobiology of pain in the Theodore Price-Greg Dussor lab and is interested in pursuing medicine after completing her undergraduate degree. Khadijah volunteers at the Monday Clinic, a free clinic supported by the North Dallas Shared Ministries, and is an undergraduate manager at the clinic for the Center of Hope shelter. She was heavily engaged in her high school art classes, which instilled a lifelong passion for painting. Her artistic pursuits have strengthened her understanding of physics, chemistry and biology, and she strives to integrate art into daily activities, such as applying principles of design to her coursework. However, the biggest lesson she has learned is that, with strong concentration, motivation and determination, any idea can be turned into a beautiful reality.

Aditya Gudapati of Plano, Texas, is a junior biochemistry major who enjoys photography, chess, and writing. He discovered his interest in photography while taking lessons from his father, a professional photographer. He enjoys taking pictures within his neighborhood, focusing on the minor details of life in order to elucidate their value. Aditya hopes to go to medical school while continuing to practice his passion for photography.

Mario Lozano of Fort Worth is a junior biology major who hopes to attend medical school for his MD/PhD. Mario attended Bethesda Christian School from kindergarten through 12th grade where he was forced (rather unwillingly at first) to study more classical writers. Alfred Lord Tennyson, Edgar Allan Poe, and F. Scott Fitzgerald are his greatest literary influences. Mario believes poetry and music serve as a means of expressing one's deepest passions, greatest longings, and innermost thoughts in a form that mere vernacular cannot convey.

Madeeha Mian is a junior biology major with minors in visual arts and Spanish. Her love for research started during her freshman year, and she currently researches at the Infant Learning Project, under the guidance of Dr. Melanie Spence. Madeeha volunteers for the Suicide and Crisis Center of North Texas and has volunteered for Baylor Hospital in Carrollton for several years. In her free time, she enjoys reading, photography, drawing, painting and running, and she also loves to travel in order to learn about the people, art, language and history of other cultures. Madeeha aspires to become a physician, a career that is an amalgamation of her love for the arts and sciences.

La Catrina Mirando a ...

This depicts a portion of a spray-painted mural that offers a modern interpretation of La Catrina. She stares intently and seductively, wearing the eyes of death.

Americana Hispanica

For 4½ years in my early 20s, I lived in Mexico, where I gained a profound appreciation of Hispanic culture, in addition to a fluent mastery of the Spanish language. The colorful and lively culture that routinely celebrates the events of life impacted me tremendously, so when I moved to Dallas, I noticed the Hispanic culture all around me a great deal more. In the spring of 2014, I took a black-and-white film photography class at UT Dallas with Dr. Diane Durant. For my final project, Americana Hispanica, I decided to explore and document Hispanic culture.

In these images, I focused on inanimate aspects of Hispanic culture in Dallas. At the same time, I sought to integrate into the images a sense of life and humanity. Therefore, in each photo, I ensured that a face is evident, giving each object life and a sense of personality.

— by Matthew Rader

Our Lady of Guadalupe Looking Down Upon ...

These statues represent the everyday religious beliefs of most people in Mexico and how those beliefs are deeply personal and real to each individual. Although lifeless, each statue becomes full of meaning and life to the purchaser.

Figurines Looking Off Into ...

These figurines represent a popular Mexican fascination with cowboys of the Wild West, revolutionary soldiers and death. The Che Guevara poster in the background symbolizes the spirit of all three.

Piñatas Looking Out At ...

Piñatas are a large part of Mexican celebrations. They represent the celebratory spirit of Mexican culture as they idly await purchase.

A Rush to the Start

I long to return to days of old.
Of mem'ries past and stories told.
A time of former friends and foes.
Of ancient joys, and ancient woes.

Times were simpler then most sure.
Life, pain, and love, more pure.
But life does not sit and linger, it runs!
Like days, clocks, and archaic suns.

So take what the ancient things give.
Lessons learned and wills to live —
Not die, and thus fade so fast.
But persevere, and pass the past.

— by Mario Lozano

This poem is about a desire to go back to the way life used to be. I wanted to "rush to the start" of everything for an extended period of time. Eventually though, I had to embrace the truth that one cannot go back to the past. The past is complete and over, and the only productive choice is to push ahead. "A Rush to the Start" is about starting new things, moving forward, and passing your past.

In Time Drives By, a car streaks down a well-lit street while someone leaves a ghost of a presence. The solid and constant presence of the street lamps, the fleeting passage of a car, and the "barely there" silhouette of a person contrast to show differing representations of time. A long, hard day might seem to go on forever, while some moments might leave one wanting more. The business of life sometimes results in us missing opportunities that we never experience again.

COLLECTION

U N T I T L E D

These images convey the concept of time. Each image is a unique depiction and understanding of time, but all convey that time moves on, regardless of external factors.

Using prolonged shutter speed, I exposed the camera to a nighttime environment where it took in the light from its surroundings—a street lamp, a passing car, and the light from an office building where a lingering employee works into the night.

The theme, then, is that we must intentionally experience our surroundings, as time "drives by."

— by Aditya Gudapati

Ghost Town *depicts a neighborhood almost devoid of life. Indicators of remaining activity are the spontaneous lights and a bright call for help that says 'S.O.S.' On some days, everything might seem lost and the world might seem like a dark place. As time goes on, things might seem to have no purpose. But even then, an attempt to call out for help will not go unnoticed by those around you and help will arrive. Time can heal just as much as it hurts, but not without a small glimmer of hope from within.*

Light Jump *was created to play with time in a more fluid sense. In contrast to the heavier subdued tones of the street lamp and the darkening background, the streaks of light in the foreground of the image serve as a symbol of "lighter" times and hope. As depicted in the images in this collection, time goes on. However, life also offers a few pleasant surprises. These are the events that will serve as a beacon, outshining darkness, and allowing for better times.*

Desolation *is meant to remind the viewer of a time when they felt lost, isolated, and hopeless. Even during that time, there will be a light that shines. It can come from something as strong as love from family and friends to a simple smile from a stranger. Regardless of the depth, there will be kindness and love in this world that will outlast everything else. Desolation, in spite of its name, demonstrates that beacon of light and how it permeates the darkness.*

Acrylic on canvas

A Million in One

Some people may see only one color in a rose. However, everything in nature carries a spectrum of hues. If we take a hurried glance, we miss the opportunity to see "a million in one." As we define our paths and grow farther away from the branches we could have chosen, some of us may decide it is wasteful and useless to pluck a leaf from the other side. However, uniting two clans from opposite sides of a mountain need not produce conflict.

This rose was given a million hues to make it more beautiful than any one color could manage. Moreover, even though the rose is a miracle in itself, it is only a participating citizen in a nation of many different miracles. Although living as one, they are by no means the same. In fact, the survival of the whole depends on each individual's unique contributions.

Through this painting, which is based on a photograph of a rose taken years ago in my backyard, I hope to show that diversity gives even the most fragile objects strength and beauty. As I drew the rose across the canvas and battled colors to create harmony, I knew that this picture, as colorful as it is, could never capture all of the dimensions granted to this one rose.

— by Khadijah Mazhar

Exploring the Other Side of Our Galaxy

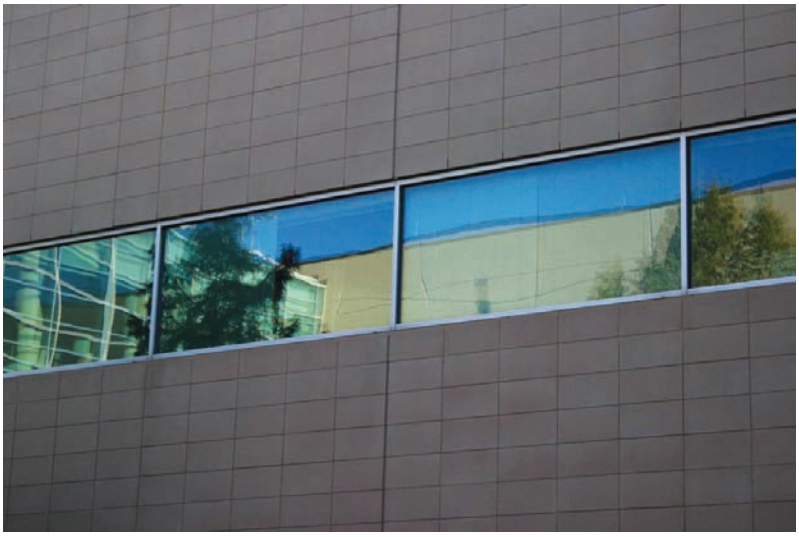
Last year, I enrolled in my first humanities and creative arts classes, which, as a biology major and pre-med student, I did purely to meet a required fine arts credit. By taking classes outside the sciences, I became immersed in intense discussions, analyzing people's motivations and influencing factors in their works, relying on senses such as hearing for analysis and exploration, and broadening my education with a myriad of perspectives. My once-dormant creative mind was now bubbling with ideas.

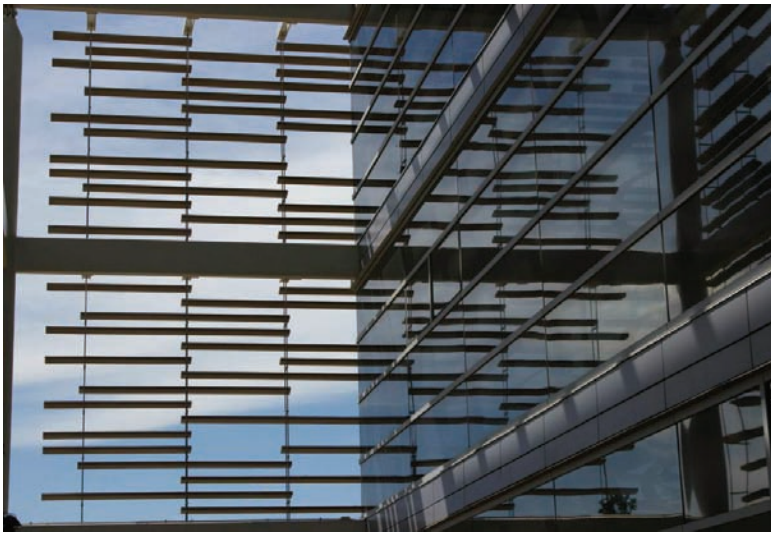
People ask why I am still taking humanities and creative arts classes as a pre-med student, having already fulfilled my degree requirements. These courses add the undeniable human element to fields outside of the humanities, such as business, engineering and especially medicine. For example, doctors can be confronted with death or patients who are depressed and emotionally distraught. When confronted with death, depression or overwhelming emotion, patients do not want doctors to function only mechanically like stethoscopes, concerned solely with data or figures; the practice of medicine, after all, is essentially about working with people.

Exposure to the humanities and creative arts has allowed me to re-evaluate my worldview. Capturing photographs of ordinary things and examining the subsequent images reveal new details, shapes, light and color in my surroundings. Photography has genuinely changed the way in which I see the world, allowed me to ask off-piste questions, and enabled me to enhance my propositions with unique viewpoints.

Exploring the Other Side of Our Galaxy is a photographic collection taken of various physical structures found on the UT Dallas campus, all of which I simply overlooked in the past. The fundamental yet unique elements of line, scale, color, texture and pattern encourage the viewer to attend to distinctive details, while keeping focus on the larger picture—a skill that has not only strengthened my skills of photography of late but also rounded me into a more perceptive pre-med student.

— by Madeeha Mian





Patti Henry Pinch Scholarship for Undergraduate Research

The Patti Henry Pinch Scholarship is designed to assist undergraduates at UT Dallas with research and travel expenses by offering supplemental financial support of up to $1,000 (half of the award will be provided by the student's school and half will be provided by Patti Henry Pinch Undergraduate Scholarship funds) on a competitive basis. Students should consult their research advisor in order to complete the application.

For more information, visit oue.utdallas.edu/research/patti-henry-pinch-scholarship.

Student Research Resources

UT Dallas offers a variety of research opportunities and resources. Engaging in research as an undergraduate has academic, personal, and professional benefits. Research activities enhance analytical and critical thinking skills, which prepare undergraduates for the rigors of their profession or graduate studies. Learning how to practically apply academic concepts, discovering how to work independently, and experiencing how to function successfully as a team member are other benefits many students attribute to participating in undergraduate research activities. Exploring a discipline through research also allows students to make informed decisions about the career they wish to pursue. The Office of Undergraduate Education (OUE) and the Office of Research provide a variety of research event opportunities and other resources to assist both prospective and current undergraduate researchers.

For more information about undergraduate research opportunities, visit oue.utdallas.edu/research/student-research-resources.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