Monday, April 24, 2017

SCIENCE RESEARCH SYMPOSIUM

Student Presenter Research Abstracts

Maylis Basturk
2019
Biological Sciences

Maylis Basturk, class of 2019, is a Biological Sciences major in Columbia College currently working as an undergraduate research assistant in a lab at the Columbia University Medical Center. This lab, headed by Michele (Mimi) Shirasu-Hiza, aims to understand how the circadian clock regulates specific immune functions using Drosophila melanogaster. The overarching goal is to use circadian biology as a prism to understand the interaction, coordination, and regulation of complex physiologies in the whole animal that contribute to survival after bacterial infection.

Maylis' role in this lab is not only to learn about circadian regulated immunity, the fundamental components of research and fly genetics but also to aid the graduate and postdoctoral student with their own research projects. Last summer, Maylis participated in the Columbia University Summer Undergraduate Research Fellowship as part of the Genentech Fellowship in Dr. Shirasu-Hiza's lab. Her project investigated the effect of environmental and epigenetic factors, such as parental age, acute and developmental stress, on survival following traumatic brain injury (TBI). Moreover, Maylis developed new protocol to inflict mild repetitive TBI and overall provided insight into using the fly as a model for TBI and potentially identifying future therapeutic interventions. As well as participating in biology research at Columbia, Maylis is a involved in GHAP HIV peer counseling and works as an EMT for Columbia University Emergency Medical Services.

Faculty Adviser: Shirasu-Hiza, Mimi

A multifaceted approach to traumatic brain injury in Drosophila

Traumatic brain injury (TBI) is the leading cause of death for individuals under the age of 40, with an estimated 5.3 million Americans living with a traumatic brain injury-related disability. Most commonly, TBI results from blunt force trauma, inertial acceleration, or deceleration force causing the brain to ricochet inside the skull. While hospitals and insurance companies often characterize traumatic brain injury as a singular event, those who suffer from a TBI sustain more than just primary injuries. TBI patients incur secondary injuries resulting from cellular and molecular responses to the primary injury, that often persist over time. Much of the research characterizing the effects and outcomes of TBI consists of retrospective human clinical studies. However, there exists immense heterogeneity in the TBI patient population, in terms of genetic, socioeconomic and environmental factors, which create significant barriers in TBI research. In this study, we investigated the effect of environmental and epigenetic factors, such as parental age, acute and developmental stress, on survival following TBI. Moreover, we developed new protocol to inflict mild repetitive TBI. While our study did not find a significant effect of parental age and stress on survival of TBI, our data provide the foundation for future studies of other factors that influence survival. Ultimately, this study provides insight into using the fly as a model for TBI, to potentially identify future therapeutic interventions.

Annie Block
2019
Sustainable Development

Originally from Philadelphia, PA, Annie has a passion for both science and dance. A sophomore in Columbia College studying sustainable development, Annie is happy to share her first research project on air filtration. Apart from her academic studies, Annie is a very active member in the dance community on campus. She has been involved in Orchesis, Columbia's largest performing arts group, and Columbia Ballet Collaborative. This year, she is the choreographer for *The 123rd Annual Varsity Show*, an original musical about life at Columbia. She is also a member of the Undergraduate Recruitment Committee and the Blue Key Society. When not dancing or studying, she enjoys watching Broadway shows, playing the piano and spending time with family and friends.

Chelsea Jean-Michel
2019
Sustainable Development

Chelsea Jean-Michel is a sophomore in Columbia College majoring in Sustainable Development and concentrating in French and Francophone Studies. Her research project on air filtration, completed with Annie Block, is her first at Columbia and she is excited to do more. Chelsea has been an actor in the 122nd Annual Varsity Show as well as the holiday production XMAS!11 and this semester is a dancer and choreographer for the largest performing arts group on campus Orchesis. She currently works at the Office of Global Programs and Fellowships as a work-study student.

Faculty Adviser: Wong, Jason Chun Yu

Air Filtration: Singapore Haze

Singapore, a small island city-state in southeast Asia, is affected by periodic occurrences of haze. This haze, of which a large portion is particulate matter 2.5 microns in diameter ($PM_{2.5}$), is primarily caused by slash-and-burn techniques used in the neighboring countries of Indonesia and Malaysia. Due to its incredibly small size, $PM_{2.5}$ causes many health risks, forcing people to stay inside or wear masks when the haze is present. Given the task of finding a solution to the problem, we came up with the idea of implementing a large-scale air filter that uses electrostatic purification. This apparatus would be installed approximately 8km off the coast of Singapore and negatively charge $PM_{2.5}$ particles, which would then be attracted to a positively charged plate, allowing clean air to flow through.

Paul Bloom
2017
Neuroscience and Behavior

Paul Bloom is a Neuroscience & Behavior major and a senior in Columbia College. After graduation, he will also be starting as a doctoral student in the Columbia Psychology Department and studying familiar music and memory. His research as an undergraduate in the Metcalfe Lab has focused on the neurocognitive consequences of the tip of the tongue (TOT) state, particularly whether this experience is associated with enhanced curiosity and memory. Paul is also a Resident Adviser in a first-year dorm, and an active pianist/keyboard player in New York City.

Faculty Adviser: Metcalfe, Janet

Tip of the Tongue States Enhance Processing to Feedback

Tip of the tongue (TOT) refers to the feeling that the retrieval of an unrecalled target word is imminent. While our pilot research indicates that TOT states are associated with increased curiosity and answer-seeking, the underlying neural mechanisms are not yet well understood. Here, we used electroencephalography (EEG) to investigate neurocognitive responses to correct feedback to a series of 150 general information questions. For questions in which subjects (n=26) were unable to answer verbally within 3s, we first prompted subjects to indicate whether they experienced TOT or not, then displayed the correct answer as feedback. Feedback while in the TOT state, as compared to feedback while not in a TOT state (and not knowing the answer), evoked enhanced late positivity in central-posterior electrodes from 250-700ms post-onset. When tested again on the same questions, subjects recalled a higher proportion of answers for questions in which they had been in the TOT state. Additionally, we conducted a single-trial analysis, and found that ERP amplitude in central-posterior electrodes predicted probability of post-test recall. These findings suggest both that feedback to the TOT state drives increased cognitive processing, and that this differential processing can improve recall.

Chiara Butler
2018
Chemistry

Chiara Butler is a chemistry major in the Columbia College class of 2018. She has spent two years researching inorganic materials in the research group of Assistant Professor Xavier Roy. She is also the Vice President and Treasurer of the Chandler Society for Undergraduate Chemistry.

Faculty Adviser: Roy, Xavier

Oxidative Addition to Nickel Phosphide Clusters and Complexes

Molecular clusters are atomically precise inorganic molecules sometimes called “superatoms” because of their discrete structures and electronic properties that are distinct from those of their constituent atoms. Recently, our group has developed a class of nickel phosphide clusters of the type $Ni_x(PR')_y(PR''3)_z$. I have explored these clusters’ potential as nickel (0) centers and their ability to undergo oxidative addition. I have demonstrated the ability of tetrakis(triethylphosphine)nickel(0) to complete oxidative addition with dibromobenzene, and done preliminary studies on the reactivity of a $Ni_{12}[PMe]_5(PEt_3)_8$ cluster with dibromobenzene. Possible applications of these reactions include the formation of organonickel products and the initial step in a catalytic cycle similar to that of the Suzuki cross-coupling reaction.

Ting (Tracy) Cao
2017
Biochemistry

Tracy is a graduating senior in Columbia College studying Biochemistry and Mathematics. She has been a research assistant at the Stockwell Lab for 2.5 years. Her research involves the chemical synthesis and biological testing of a class of compounds named ferrostatins which have therapeutic potential towards degenerative diseases such as Huntington's and Alzheimer's. Besides her research, Tracy is also involved in the senior class student council, and is the Director of Finance for the Ivy Policy Conference held at Columbia University this April.

Faculty Adviser: Stockwell, Brent

Synthesis and Evaluation of Ester and Amide Substituted Ferrostatin Analogues

Ferroptosis is a regulated form of non-apoptotic, iron-dependent, oxidative cell death that has been shown to be involved in many degenerative diseases such as Huntington's and Alzheimer's. Ferrostatin-1 (Fer-1) is a small molecule that is a potent inhibitor of ferroptosis. Fer-1 effectively inhibits oxidative lipid damage but is metabolically unstable, thus limiting its in vivo application. Our group's earlier studies had shown that replacement of the ester moiety in Fer-1 with an amide moiety resulted in significantly decreased potency. More recently, it has been reported that amide substituted analogues of Fer-1 have increased stability while retaining high potency. In this study, we sought to verify if this were true. We designed and synthesized ester and amide substituted ferrostatin analogues through 5-6 step syntheses, including a novel analogue CT-020 predicted to have increased metabolic stability. The ability of these analogues to inhibit ferroptotic cell death induced by small molecules (10 µM erastin or 1 µM RSL3) were tested in HT1080 fibrosarcoma cells and their potency evaluated through presto blue cell viability assays. Through comparing the potency of these compounds, we were able to establish a clearer structure-activity relationship. Our results also confirmed the enormous potential of amide analogues as highly potent inhibitors of ferroptosis with half maximal effective concentrations of within 100 nM, and predicted better stability. Our current ongoing research focuses on studying the microsomal and plasma stability of these compounds, and we anticipate studies of these compounds in Huntington's mouse models.

Anna Chen
2018
Biological Sciences

Anna Chen is a junior from Toronto majoring in Biological Sciences. Since September 2015, she has been working in Dr. Mimi Shirasu-Hiza's lab at the Columbia University Medical Center, studying the relationship between circadian rhythm, immunity, and aging. This summer, Anna participated in the Columbia Physicians and Surgeons Summer Undergraduate Research Fellowship (P&S SURF). Her project, "Circadian Regulation of Drosophila melanogaster Mitochondrial Uncoupling Proteins," investigated the role and regulation of mitochondrial uncoupling proteins in the fruit fly. Outside of research, Anna is a Resident Adviser in McBain Hall, the Vice President External of the Asian American Alliance, a volunteer at Harlem Hospital, a counselor at Camp Kesem, and a member of the Global Recruitment Committee.

Faculty Adviser: Shirasu-Hiza, Mimi

Circadian Regulation of Drosophila melanogaster Mitochondrial Uncoupling Proteins Modulates Survival to Infection

While the molecular mechanisms of circadian regulation are well studied, the relationship between circadian rhythm and energy metabolism is not well known. Using the Drosophila model, we have previously observed that circadian period mutant flies showcase several hallmarks of mitochondrial uncoupling, including increased food intake, decreased lipid storage, and increased respiration, respective to circadian wild-type flies. Here, we consider the role and regulation of mitochondrial uncoupling proteins (UCPs), specifically UCP4C and UCP5, in relation to circadian rhythm and infection immunity. By quantifying expression levels at different circadian time-points, we showed that UCP4C and UCP5 are circadian-regulated in wild-type flies and upregulated in circadian period mutant flies. Additionally, we identified that both chemically increasing uncoupling levels and genetically decreasing uncoupling levels decreases infection survival to B. cepacia, suggesting that uncoupling is beneficial to infection survival only in a narrow, biological range.

Celine Chen
2019
Biological Sciences

Celine Chen is a sophomore in Columbia College majoring in Biological Sciences and concentrating in Visual Arts. As a member of Dr. Brent Stockwell's lab, she conducts research on ferroptosis, an iron-dependent, non-apoptotic form of regulated cell death with various implications in human diseases and cancers. Specifically, her project attempts to develop biochemical assays in order to detect biomarkers of the ferroptotic pathway in order that these assays may be applied to human brain tissue samples with neurodegenerative diseases. Aside from research, Celine is a member of Columbia Global Brigades, through which she has had the chance to work on on medicine and health-related holistic development projects in Honduras and Panama. She is also a member of Barnard-Columbia Design for America and the *Journal of Global Health*. Celine wants to explore the intersection between her interests in the arts, biology, and global health.

Faculty Adviser: Stockwell, Brent

Development of Biochemical Assays for Monitoring Ferroptosis in Cell Lysates

Cell death is crucial for many physiological processes and the maintenance of homeostasis. However, when over-activated or suppressed, it can lead to degenerative diseases and cancer respectively. Ferroptosis is a non-apoptotic regulated form of cell death, driven by the loss of the lipid repair enzyme glutathione peroxidase 4 (GPX4) and the subsequent accumulation of lipid reactive oxygen species. Evidence of ferroptosis has been detected in cell culture and animal models of degenerative diseases e.g., Huntington's disease, but not yet in human tissue samples. Developing simple but reliable methods for the detection of ferroptosis is important for documenting ferroptosis in specific human diseases, which will aid the search for a therapeutic approach to treat these diseases. Here we show that two metabolites, glutathione and lysoPC, undergo predictable and reproducible changes in cells during ferroptosis. Whereas previous methods used liquid chromatography-tandem mass spectrometry, we sought to optimize more accessible and efficient alternative methods to quantify these metabolites. In future experiments, these methods could allow us to detect the presence of ferroptosis directly in neurodegenerative human tissue samples.

Helen Chen
2017
Environmental Biology

Helen Chen is a senior in Columbia College studying Environmental Biology. Her work for her senior research thesis examines how a host life history traits can help identify species more susceptible to pathogens, with implications for public health and conservation. On campus, Chen is also president of CU Pre-Vet Society and is a four-year dancer and choreographer on Sabor: Columbia University's First Latinx Dance Troupe.

Faculty Adviser: Olival, Kevin

The Relationships Between Host Life-History Traits and Viral Richness in Birds

There are over 10,000 species of birds, and many aspects of their natural history could make them particularly effective viral reservoirs. Studies conducted on mammals have identified several host life-history traits that may be predictors for viral richness, and experiments on birds have demonstrated relationships between life history and immunocompetence. This project updates an existing database of avian host-virus associations compiled in 2011 now containing 1,907 associations involving 142 viral species and 929 host species. The updated database also incorporates host life-history traits. Database analysis includes descriptive statistics and generalized linear models; analysis identified higher basal metabolic rate, greater maximum longevity, herbivory, increased host research effort, and increased average clutch size as predictors of increased viral richness. With the occurrence of several deadly viral outbreaks such as Ebola, SARS, and Zika in the last decade, much research attention has turned to studying emerging infectious diseases (EIDs), a disproportionate amount of which are zoonotic viruses. Identifying life-history traits as predictor variables provides information on which avian species might be particularly good viral reservoirs. These analyses contribute to a more complete picture of viral richness across the animal kingdom and suggest more targeted viral detection efforts in response to potential conservation and public health threats.

Alexander Cody
2018
Biological Sciences

Alex is a current Biological Sciences major in Columbia College planning to graduate in 2018. He was raised in Salt Lake City, Utah, and many of his extracurricular activities revolve around the outdoors, such as soccer and skiing. Along with these, he also volunteers at the Boys and Girls Club of America-Harlem and at the Friend for Rachel Dementia Program at Columbia University Medical Center. His research was performed at the Mayo Clinic through their Summer Undergraduate Research Fellowship (SURF) in the department of Biomedical Engineering and Physiology. The primary focus of his work was to understand the physiological alterations of the heart and its internal energetics following hypothermia.

Faculty Adviser: Sieck, Gary

Rewarming Shock Decreases Oxygen Consumption Rate in Cardiomyocytes

Hypothermia/Rewarming (H/R) induces cardiac contractile dysfunction; however the underlying intracellular mechanisms remain elusive. We hypothesized that in cardiomyocytes, H/R decreases oxygen consumption rate (OCR), which may be related to reduced myocardial function due to insufficient matching of the metabolic demand. To test this hypothesis, isolated cardiomyocytes from 6 rats underwent the H/R protocol as follows: cardiomyocytes were electrically stimulated (every 2 s) throughout the protocol; experimental temperature was cooled from 35oC to 15oC in 30 min, maintained at 15oC for 2 h, and then rewarmed back to 35oC in 30 min. Time-matched control cardiomyocytes were stimulated every 2 s for 3 h at 35oC. After 3 h, control and H/R cardiomyocytes were placed into separate chambers of an Oroboros Oxygraph (high-resolution respirometry) to measure OCR under varying conditions. Initially basal OCR was measured for 5 min followed serial exposure to oligomycin (1 μM for 5 min) to block ATP synthase activity, FCCP (0.5 μM repeated 3 times for 5 min each) an H^+ ionophore to dissipate mitochondrial membrane potential; and antimycin-A (0.5 μM for 5 min) to block the electron transport chain. This procedure allows us to assess the key parameters of mitochondrial respiratory function: basal and maximal respiration (after FCCP exposure), ATP production and proton leak (after oligomycin), and reserve respiratory capacity (calculated after antimycin-A). H/R decreased all of these key parameters of mitochondrial function, which suggests that decreased OCR following rewarming may contribute to contractile dysfunction due insufficient matching of ATP supply and demand, as well as by contributing to a decline in cell viability (e.g., triggering apoptosis).

Dylan Cooper
2018
Neuroscience and Behavior

Dylan Cooper is a junior in Columbia College hailing from Memphis, Tennessee, studying Neuroscience and Behavior, though he tends to focus more on the former. Since conducting research in summer 2016 at the New York State Psychiatric Institute in the Siegelbaum Lab, he has been investigating the neuronal and morphological characteristics of the hippocampus affected by neuropsychiatric diseases, specifically schizophrenia. Dylan serves on the Executive Board of Hillel as the Vice President of Communications, works as a peer adviser at the Center for Student Advising and the Psychology Department and plays on a competitive intramural basketball team. He hopes to continue his work on the hippocampus as his thesis in the Honors Psychology Program.

Faculty Adviser: Siegelbaum, Steven

The Role of CA2 in the Context of Neuropsychiatric Diseases

Autism Spectrum Disorders (ASD) and Schizophrenia (SCZ) are cognitive, neuropsychiatric disorders with individually complicated neurobiological architectures but common behavioral pathologies, such as impaired social cognition. Accumulating evidence reveals a strong genetic association within these pathologies, and the advent of genetically modified mouse models allows for an in-depth analysis of their underlying mechanisms. Our research aims to determine if the CNTNAP2 and Nrg1 loci, linked to ASD and SCZ in humans, respectively, result in an impaired network connectivity of area CA2, a region in the hippocampus that has recently been identified as crucial for the encoding of social memory. We employ electrophysiological and immunohistochemical techniques to determine whether these mouse models display: (a) a loss of PV+ interneurons in area CA2 (which has been observed in brain tissue from individuals with schizophrenia or bipolar disorder), and (b) altered intrinsic excitability or synaptic circuitry of CA2 pyramidal neurons (which was observed in a separate mouse model of schizophrenia). Understanding the cellular and molecular changes that take place in this brain region may shed light into the etiology of these disorders and may uncover novel targets for future drug development.

Andre Fiks Salem
2019
Neuroscience and Behavior

Andre Fiks Salem is a sophomore in Columbia College studying Neuroscience and Behavior on the premed track. Hailing from Brazil, Andre came to Columbia to study film but was persuaded by the exciting developments in neuroscience on campus and the prospect of helping people through medicine. Pivotal to this transformation were Frontiers of Science lectures and, of course, the unbiased approach to science of his Principal Investigator, Dr. Martin Chalfie. When not in classes or in the laboratory testing microscopic worms, Andre enjoys photography, juggling and watching movies. His ultimate goal is to become a physician, as he believes healthcare can holistically improve people's lives and empower them to achieve their goals.

Faculty Adviser: Chalfie, Martin

A method to identify touch super sensitive mutants of Caenorhabditis elegans using mec-4 ts double mutants

In spite of research that defined the molecules essential to vision, smell and taste, researchers still do not know or fully understand all the molecules responsible for mechanical senses. Scientists have learned about some of the proteins essential to mechanosensation in mutants of the *C. elegans* roundworm in which it has been genetically disrupted. The mutations are provoked by random chemical mutagenesis, which should yield insensitive as well as super sensitive mutants. However, the super sensitive mutants have not been studied because their phenotype cannot be discriminated easily from the already responsive wild type in the standard touch assay.

We tested alterations to this assay in order to reduce overall response rate and allow super sensitive mutants to stand out from wild type. We concluded substituting the wild type for the temperature sensitive *mec-4(u45)* mutant, which has a reduced response rate at 22°C, will be helpful to identify super sensitives. In this new test, response rates to touch would be low and any animal that reverts to a high response should possess, along with the u45 allele, a super sensitive mutation. In the future, we will use this method to test strains with suspected enhanced sensitivity and hopefully allow more research in the genes causing this phenotype so that we can further understand how organisms feel touch.

Andres Garcia
2017
Environmental Science

Andres Garcia, born in Pharr, Texas, is an Environmental Science major concentrating in Environmental Biology. Throughout his four years in Columbia College, he has worked communicating the importance of and campaigning for the extension of environmental protections. When not in class, Andres has worked at the Gap, interned at Environment New York, and acted as a mentor to high school students across the South Texas border aspiring to apply to higher education, particularly Ivy League institutions. With the help of CUSP, Andres has gotten to know issues affecting Columbia's Harlem neighbors, and through the Speakers Series has been introduced challenges to address as a global citizen. Andres is now researching plant respiration with the goal of fine-tuning carbon models. After graduation, he ultimately hopes to earn a PhD in Plant Biology and continue researching plant physiology.

Faculty Adviser: Griffin, Kevin

Assessing the Kok Effect in Select Crop Species Through Photosynthetic Inhibition

Terrestrial plant respiration at low light levels has been shown to occur at a lower rate than would happen at more typical levels of photosynthetically available radiation, a phenomenon known as the Kok effect. Although the direct effects of light on photosynthesis are well-documented, the effects of light on respiration are not as apparent, as there is no direct link between photons and the respiratory metabolic pathway. Thus, this thesis aims to inhibit photosynthesis and measure respiration directly along a light gradient through the use of a photosystem II inhibitor, DCMU. Common crop plants—*Phaseolus vulgaris* (bean), *Zea mays* (corn), *Raphanus sativus* (radish), *Solanum melongena* (eggplant), and *Glycine max* (soybean)—were grown in a growth chamber, inhibited through a liquid solution of DCMU applied directly to the leaf surface, then measured in a gas exchange unit. This study finds that in the absence of photosynthesis, no Kok effect can be seen on any C3 photosynthesizers—every crop except for Z. mays. Measurements from the Z. mays leaves, a C4 photosynthesizer, do not show a Kok effect, but do respond to DCMU inhibition similarly to C3 plants. These findings indicate that the Kok effect is activated either in the photosynthetic or photorespiratory metabolic pathway, both of which use the enzyme Rubisco to catalyze carbon dioxide. Due to the widespread applicability of the DCMU application method used in this experiment, this study serves as a potential stepping stone to examine dark respiration in a variety of contexts that ultimately may be used to modify a wide range of human interests, from carbon models used for scientific and policy purposes, to agricultural efficiency and yield for an increasingly habited Earth.

Zachary Heinemann
2017
Psychology

Zachary is a Dual BA / MA student pursuing his BA in Psychology and Statistics in Columbia College and his MA in Data Science in the Graduate School of Arts and Sciences. His research has bridged the gap between health, psychology, and advanced statistical techniques to evaluate and monitor health and policy programs. Over his time at Columbia, he has done research in five labs on campus within the Psychology department and Business School and does work on the tangible effects of diversity and inclusion in academics, health, and social networks. This past summer he spent 10 weeks in Nairobi, Kenya doing statistics to evaluate the psychological effects of a government intervention run through Columbia's NGO ICAP.

Faculty Adviser: Ruby Fayorsey

Perceived Social Support and Depression amongst Pregnant and Postnatal Women with HIV in Nyanza, Kenya

In order for prevention of mother-to-child HIV transmission (PMTCT) programs to be effective, they must identify pregnant women living with HIV, provide them with antiretroviral treatment (ART), support medication adherence, and retain patients to ensure that infants receive the appropriate care including final determination of HIV status. Previous research has demonstrated that depression is a barrier to retention in PMTCT programs and that perceived social support is a key facilitator.

Between September 2013 and August 2015, 340 HIV positive, pregnant women seeking PMTCT services enrolled in the MIR4Health study, a randomized trial conducted at ten health facilities within the Nyanza region of Kenya. Women were assigned to either the standard of care or intervention, the latter involving a lay worker administered package of services including individualized health education, adherence and psychosocial support during clinic visits and at home, peer support, and text and phone call appointment reminders intended to improve retention. Clinical data and patient interviews were collected longitudinally from enrollment through six months postpartum. Perceived social support was assessed as a 12-item self-reported survey, including emotional and instrumental support items, at two time points; depression was assessed via a 10-item survey at 3 time points. We used first-differences regression models to explore the relationships between perceived instrumental support, perceived emotional support, and depression amongst patients in the intervention and control arms of the study.

Analyses found that the intervention had an impact on perceived availability of emotional support ($p < .05$), but did not have any effect on instrumental support ($p > .05$). Using the Edinburgh Postnatal Depression Scale (EPDS), we found that instrumental support was predictive of depression ($p < .05$) but emotional support was not ($p > .05$).

This research demonstrates that the package may have had an impact on emotional social support which has been associated with positive health outcomes. Further research may be necessary to unpack which components of the package were most or least beneficial to the effects found and therein how the intervention should be modified before wide scale implementation.

Christin Hong
2018
Biochemistry

Christin Hong is a junior studying Biochemistry and pursuing a career in medicine. She has been part of Dr. Wesley Grueber's lab since sophomore year and has learned various techniques related to Drosophila melanogaster research. She investigated the mechanism of age-induced degeneration with her mentor in the Grueber lab, Dr. Jennifer Ziegenfuss, during her summer 2016 internship through Columbia's SURF program. She is now studying the role of mitochondrial motility in age-induced degeneration. When she is not dissecting open fly abdomens, Christin is heavily involved in various engagements. She is a Resident Adviser in Schapiro Hall, an active member of Columbia's Redeemed University Fellowship (RUF), a participant of A Friend for Rachel and a volunteer at Mount Sinai St. Luke's Emergency and Geriatrics Departments.

Faculty Adviser: Grueber, Wesley

Elucidating the Mechanism of Age-Related Dendrite Simplification in Drosophila Peripheral Sensory Neurons

Aging is a process that affects everyone. However, the biological basis of aging is still largely unknown. This natural phenomenon is associated with a decrease in cognitive ability, motor, and sensory function and increased incidents of neurodegenerative diseases such as dementia and neuropathy. Consequently, aging and age-induced decline of neuron and nervous system connectivity and structure greatly impact both the longevity and quality of life. Degeneration in neurons occurs by a number of different cellular mechanisms. Developmental degeneration proceeds via caspase-mediated pathway and induces dramatic reorganization and morphological changes in neurons. In contrast, Wallerian degeneration (WD) is triggered by toxins or axotomy that results in extensive breakdown of the axonal cytoskeleton and terminal arbors, ultimately leading to cell death. Age-induced degeneration is another degenerative pathway that can significantly affect the vitality and function of neurons. However, not much is understood about the mechanism of this pathway. Our aim is to illuminate the mechanism of age-induced degeneration by using the tools provided by both Wallerian degeneration and caspase-mediated degeneration. Previous findings show that the slow WD mutation (Wlds) delays the onset of WD. Overexpression of p35, an inhibitor of effector caspases, was found to influence developmental degeneration by blocking pruning-induced dendritic branch removal. In this project, we investigate the role of p35, wlds, and mitochondria in age-induced degeneration. We postulate that age-induced degeneration may exhibit morphological changes that share similarities with both WD and caspase-mediated degeneration.

Claire Huang
2017
Ecology and Evolutionary Biology, Environmental Science

Claire Huang is a senior in Columbia College studying Ecology, Evolution and Environmental Biology. Growing up in the surburbian shadow of the Rocky Mountains in Calgary, Canada, Claire was one of those kids who literally thought she was a wolf and ate bugs off of trees – maybe a little too in touch with nature. But that's exactly why she's studying Environmental Biology. She loves all animals and is interested in conservation research in marine ecosystems. Last summer and fall, Claire completed her senior thesis in Oregon with Columbia departmental funding, researching the effects of El Nino on rockfish reproduction (and looked at lots and lots of gonads). At Columbia, she is the President of the Badminton Club, the Chief Illustrator of the Columbia Science Review and is the loving mother goose (i.e. Resident Adviser) in her residence hall.

Faculty Adviser: Heppell, Scott

Shifting Baselines in Oregon Female Black Rockfish Size and Age at Maturity: El Nino Impacts on Reproduction

Black rockfish (*Sebastes melanops*) are a valuable fish species for West Coast fisheries that are overexploited, experiencing age truncation. There are few studies examining the maternal effects and reproductive life histories of black rockfish. This study seeks to assess how maternal size and age are related to maturation state in reproductive individuals. From August to November 2015, we collected fish samples from recreational chartered boats in Newport, Oregon. We used gonad histology to determine maturation state, and sagittal otoliths to estimate fish ages. Female black rockfish were 50% mature at 390.3mm total length and 6.3 years old; the fish at 50% maturation appeared to be smaller and younger than those measured in previous studies. It is known that older, larger females have greater reproductive potential, and trends of early maturity may negatively impact the spawning biomass population as a whole. Higher levels of atresia were present in older females, and during July and August, which corresponded to the timing of the El Niño related Pacific "warm blob" and suggest a possible stress response mechanism. The effect of El Niño temperature variability on reproductive patterns requires multiple years of sampling beyond this study. It is important to assess the current reproductive potential of the population for effective management plans that conserve old-age structure.

Jacob Irwin
2018
Computer Science

Jacob Irwin is a computer science major at Columbia University in the City of New York, wrapping up his third year of coursework in Intelligent Systems. His research focuses include single-board computer hardware and application programming, financial engineering, asteroid mining database architecture, and software for the facilitation of interstellar trade and commerce. In January, Jacob was one of 200 students invited from across the country to present his *Multi-ILI9341 SPI LCD Display from a Single-board Computer* research at Harvard University's NCRC 2017 Conference. In March 2017, Jacob published a scientific paper, *Financial Markets for Interstellar Trade and Commerce*. Jacob also contributes his time on campus to Columbia's non-profit umbrella Community Impact, where he currently holds the position of Webmaster.

Faculty Adviser: Edwards, Stephen

Multi-ILI9341 SPI LCD Display from a Single-board Computer

Using a credit card-sized single-board computer, 9 integrated ILI9341 SPI LCDs displaying real-time data from the World Wide Web via an application programming interface (API). To demonstrate practical application, all 9 ILI9341 SPI LCDs are embedded in a canvas substrate; simultaneous display of contextual information: worldwide markets data. There now exist miniature computers the size of credit cards, which contain substantial computing power and permit extensible solutions for a multitude of real-world problems (namely, the high costs historically associated with building practical computer-driven machines and devices). Jacob's academic research, Multi-ILI9341 SPI LCD Display from a Single-board Computer, relies on the use of one such miniature computer, the Raspberry Pi 3 - Model B+, which powers data renderings on 9 daisy-chained 2.2" SPI TFT LCDs. These LCDs are akin to the touch-enabled LCD surface on most modern smartphones. The choice to display real-time markets data on nine distinct LCDs, i.e., by embedding each LCD in a canvas substrate that illustrates the world map, aligns with Jacob's interests in computer science, mechanical engineering, and finance. Moreover, this practical application provides a meaningful example, which demonstrates the power of 9 LCD panels—powered by a credit card-sized single-board computer—enriching traditional contextual visualizations by bringing together both the digital and non-digital: combining the two most prevalent mediums used in productivity tools and information-centric technologies.

Christy Jenkins
2017
Earth Science

Christy Jenkins is a senior Earth Science major in Columbia College. Her current research focuses on using satellite images to monitor volcano hazards in Hawaii. Previous research focused on using ocean color satellite data to monitor phytoplankton communities along the Eastern US Atlantic coast. Christy is from Tulsa, Oklahoma, and is also involved in the management of the Columbia Bartending Agency.

Faculty Adviser: Small, Chris

Temperature Approximation of Kilauea's Summit Lava Lake, Utilizing Landsat 8 Nocturnal Imagery

Lava lakes provide scientists with the most direct way to observe magma dynamics. They are also some of the largest contributors of volcanic gases to the atmosphere. These gases can affect communities and agriculture at regional and local levels. Obtaining accurate surface temperature measurements is one of the keys to better understanding magma and open-air degassing dynamics. In-situ measurements are costly and are limited to easily accessible volcanoes, thus cost-free remotely sensed data are often relied upon. The thermal infrared channels of satellites are not specifically designed to measure volcanoes and therefore, lack the dynamic range needed to capture their maximum temperatures. A study conducted by Zhizhin et al. used VIIRS optical data to detect gas flaring in pixels by fitting the values to a 2,223K Planck curve—the temperature of gas flares (Zhizhin, *APAN*, 2013). Building on this method, I show that the peak emittance temperature of lava lakes can be derived by fitting the Planck curve to nocturnal data from the unsaturated short-wave infrared (SWIR) and near-infrared (NIR) channels of the Landsat 8 Operational Land Imager (OLI) sensor. This method provides more precise thermal surface brightness temperature measurements of lava lakes for the study of magma and degassing dynamics, even in areas where daytime remotely sensed data are unusable due to extreme cloud coverage.

Mariko Kanai
2017
Biological Sciences

Mariko Kanai is a senior in Columbia College majoring in Biological Sciences. For the past three years, she has worked as an undergraduate research assistant in Dr. Gordana Vunjak-Novakovic's lab to enhance the immunomodulatory properties of mesenchymal stem cells (MSCs) for therapeutic use. After graduation, she will pursue a PhD in biology and work with her mentor to commercialize the MSC therapy developed in Dr. Vunjak-Novakovic's lab. Mariko has also been involved in GlobeMed at Columbia (former Co-President), Columbia Japan Society (former Secretary), Chamber Ensemble (Violin) and Consortium for Japan Relief.

Faculty Adviser: Vunjak-Novakovic, Gordana

Dual-priming (IFN-?/hypoxia) is More Effective than Either Priming Alone in Making Mesenchymal Stem Cells More Functionally Immunosuppressive

Adipose-derived mesenchymal stem cells (MSCs) are multipotent stem cells that are capable of adopting an immunosuppressive phenotype. Thus, they are attractive candidates for cell therapies to treat inflammatory disorders. However, previous in vivo studies have shown variable results and less effective immunosuppression than expectations based on predictions from in vitro studies. This discrepancy may be associated with the use of MSCs lacking exposure to the right environmental cues. Since IFN-γ and hypoxia are common to situations of immune escape and tolerance, we hypothesized that an in vitro dual-priming with IFN-γ/hypoxia could make MSCs more uniformly immunosuppressive. Here, we report that dual-primed (IFN-γ/hypoxia) MSCs show mRNA upregulation of factors involved in immunomodulation that requires at least 8 hours of priming and lasts for one week, have the most pronounced functional inhibitory effect of CD4 T cell proliferation compared to single-primed MSCs, and meet energy needs through glycolytic anaerobic respiration.

Pooja Kathail
2018
Computer Science

Pooja Kathail is currently a junior studying computer science. For the past two years, she has been working in the lab of Professor Dana Pe'er, exploring her interest in the intersection of computer science and biology. She has helped develop multiple computational tools to allow biologists to gain novel insight from high-throughput genomics data. Outside of research, Pooja is also involved in EcoReps, the environmental club, and is a tour guide with the Undergraduate Recruitment Committee.

Faculty Adviser: Pe'er, Dana

Building Infrastructure for Single-Cell Data Analysis

Single-cell technologies are making it possible to study complex biological systems with unparalleled resolution. However, statistical and computational methods to analyze single-cell data are still lacking. Here, we develop infrastructure to assist and empower single-cell analysis. We explore different methods for differential expression analysis in single-cell data and develop a graphical user interface for the imputation of sparse single-cell data. These steps will no doubt assist in future single-cell studies.

Ashley (Hyun Ah) Kwon
2018
Biological Sciences

Ashley Kwon is a junior in Columbia College majoring in Biological Sciences and planning to graduate in Fall 2017. Ashley developed a strong interest in research last summer when she participated in the Physicians & Surgeons Summer Undergraduate Research Fellowship (P&S SURF) at the Columbia University Medical Center. Under the guidance of Dr. Angela Christiano and Eddy Wang at the Christiano Lab in the Dermatology Department, Ashley has worked on identifying the autoantigens in the pathogenesis of Alopecia Areata. In addition to research, she is involved in organizing and providing educational services and mentorship to the general public in the city as the Project Head of a non-government organization called Edonation. In her spare time, Ashley enjoys cycling at Soulcycle, discovering new eateries in the city and jogging around the Central Park.

Faculty Adviser: Christiano, Angela

Identifying Autoantigens in Alopecia Areata

Alopecia Areata (AA) is considered a cell-mediated autoimmune hair loss disorder. Unknown autoantigen(s) attracts and induces an immune response from the T cells. Our work narrows down the potential autoantigen targets that can trigger high T cell responses in mouse models of AA. We have performed Co-Immunoprecipitation and Enzyme-Linked ImmunoSpot (ELISpot) assay on total proteins extracted from mouse skin samples to see if these approaches can be applied to studying the potential autoantigens involved in AA pathogenesis. We observed higher frequency of T cell activation when AA mouse lymph node cells (LNC) were stimulated with total skin protein compared to the control mouse in vitro. Thus, there were antigens in the AA mouse skin that can induce a T cell response. Potentially, the work here would further our understanding on the pathogenesis of AA and lead to developing more effective, targeted treatments for AA patients.

Tianjia Liu
2017
Environmental Science

Tianjia (Tina) Liu is a Columbia College senior studying environmental science in the Department of Earth and Environmental Sciences. The main goals of her current research and senior thesis are to quantify 1) burned area from winter crop residue burning in Northwest India (Punjab and Haryana) for a new emissions inventory and 2) the contributions of agricultural fires to air pollution in populous Indian cities, such as Delhi, Bengaluru and Pune. She is concurrently working on a project concerning the links between fire emissions and land use change in Indonesia. She uses a combination of remote sensing, GIS and statistical modeling. In the past, she worked at Lamont-Doherty Earth Observatory and Woods Hole Oceanographic Institution on a variety of topics from physical oceanography to paleoceanography to organic biogeochemistry.

Faculty Adviser: DeFries, Ruth

Combining Landsat and MODIS imagery to re-estimate burned area from winter agricultural fires in northwestern India

Agricultural burning is an important but poorly quantified source of outdoor biomass burning emissions and contributor to air pollution in India. In northwestern India, the intensive time crunch between harvest and sowing in the kharif-rabi (monsoon-winter) double cropping system and the increasing trend toward mechanization leave farmers little choice but to burn the crop residue. In this study, we use Google Earth Engine to develop a method that combines high-resolution Landsat (30m x 30m) and moderate-resolution (500m x 500m) MODIS imagery to estimate winter agricultural burned area from the 2003-2014 monsoon crop residue burning seasons, defined as early October to late November, in Punjab and Haryana. Based on the normalized burn ratio (NBR) of pre-fire and post-fire scenes, we estimate approximately 2-5 times more burned area than the MODIS MCD64A1 burned area product, which is used in the Global Fire Emissions Database, version 4 (GFEDv4). The significant underestimation of MODIS MCD64A1 suggests that moderate-resolution imagery cannot capture many small fires and that agricultural fire emissions in GFEDv4 are similarly underestimated. In future work, we will use the estimated burned area of this study to build a CO_2 emissions inventory to run high-resolution atmospheric models and reevaluate the public health impacts of agricultural burning.

Kelsey Markey
2017
Environmental Science

Kelsey Markey is a senior in the School of General Studies. She came to Columbia after a career in fashion and is now completing her degree in Environmental Science. Her current research focuses on drilling mud and crude oil contamination resulting from the Deepwater Horizon oil spill. Previous research focused on agriculture and nutritional diversity in the Millennium Villages Project. In her free time, she enjoys attending concerts and traveling.

Faculty Adviser: Yan, Beizhan

The Footprint of Barium and Crude Oil Following the Deepwater Horizon Oil Spill

There is still much uncertainty regarding the amount of contamination and fate of pollutants following the Deepwater Horizon oil spill. This study attempts to quantify the amount of barite, a weighting agent for drilling mud, used during cleanup efforts. High levels of barite have been shown to have a negative impact on benthic communities, an effect which is worsened in the presence of hydrocarbons. To estimate the amount of barite added following the spill, this study examined transport mechanisms and conducted a spatial analysis of barium (the main component of barite) in sediment chemistry data. Though it is widely assumed that barite particles would remain near application sites, we found evidence that barium levels were elevated (> 350 ppm) in surface sediments up to 8.5 km away from the wellhead location. We also compare differences in the spatial distribution of barium and total petroleum hydrocarbons (TPH) to consider transport differences between barite and crude oil. Ratios of chromium to aluminum (Cr/Al) and of polycyclic aromatic hydrocarbons (PAH) were also calculated to further understand the varying advective processes of heavy and light oil components following the spill. A better understanding of the fate and transport of pollutants is vital to an understanding of the threats posed to marine ecosystems and will help to influence the actions of responders in future events. Additionally, considering the widespread use of barite in the oil and gas industry, the implications of the far transport and long residence time of barium are important in considerations of the environmental impact of hydrocarbon exploration and drilling.

Rachel Mikofsky
2018
Neuroscience and Behavior

Rachel is a neuroscience major in Columbia College Class of 2018. She is planning to pursue an MD/PhD after graduation to study translational biomedical research. She has been working in the Sulzer Lab since January 2015. Her research focuses on the dopamine circuitry of the basal ganglia and its changes with Parkinson's disease. She is President of the Columbia Neuroscience Society, an undergraduate group that puts on lectures, workshops and educational events about neuroscience. Rachel is also passionate about educational outreach and is president of the CU Educational Studies Program. Rachel is also a teaching assistant for Science of Psychology this semester.

Faculty Adviser: Sulzer, David

Evidence of synchronous and asynchronous activity between left and right striatum in both direct and indirect paths during goal oriented behaviors in mice

Striatal spiny projection neurons (SPNs) regulate movement through two major circuits in the basal ganglia. The direct pathway SPNs expressing D1 receptors (dSPNs) directly project to the substantia nigra pars reticulata (SNr) and globus pallidus externa (GPe). The indirect pathway SPNs expressing D2 receptors (iSPNs) trigger a multisynaptic circuit, synapsing to the globus pallidus interna (GPi), which then projects to the SNr /GPe. Activation of the direct and indirect paths correlates with enhanced locomotion in mice and dysfunction in both is implicated in the pathology of Parkinson's disease. To our knowledge, previous studies have not delineated the extent of synchronous activity between left and right striatum in the direct or indirect pathways during locomotion. We used time correlated single photon counting (TCSPC) (χ2- 202 ChiSquare Bioimaging), an optical recording method, to record neuronal activity in the direct and indirect paths in both the left and right dorsal lateral striatum. D1-Cre (direct path) and A2ACre (indirect path) mice were injected with AAV9 Flex GCaMP6f virus. Imaging fibers were implanted in both the right and left dorsal lateral striatum. Mice were recorded with a high speed video camera framelocked to the sampling rate of the TCSPC machine. This enables simultaneous recording from both the left and right dorsal lateral striatum at millisecond precision, allowing us to correlate locomotor behavior with GCaMP6f changes in fluorescence. Interestingly, in preliminary results we find evidence of both synchronous and asynchronous activity in amplitude and frequency of firing in dorsal lateral striata during goal oriented behaviors in mice.

Osman Moneer
2018
Chemical Physics

Osman Moneer is a junior in Columbia College majoring in Chemical Physics. His research interests lie at the intersection of physics and chemistry, and he is specifically concerned with the interaction of light and matter. Osman currently studies interlayer excitons in two-dimensional materials. Outside of class, he is involved in the Undergraduate Recruitment Committee, the *Columbia Undergraduate Science Journal*, and volunteer tutoring through Top Honors.

Faculty Adviser: Zhu, Xiaoyang

Momentum Conservation of Interlayer Excitons in Two-Dimensional Materials

Because two-dimensional transition metal dichalcogenides (TMDC) are atomically thin semiconducting materials, TMDC heterostructures provide a great model system to study charge transfer across a simple interface. In the long term, TMDC heterostructures are a viable option for incorporation into ultrathin electronic systems. We are interested in understanding the physical nature of momentum conservation of interlayer excitons across a TMDC heterostructure. The aim of this research is to understand momentum conservation as a function of the orientation of the two layers of TMDCs. We fabricated TMDC heterostructure devices, which consisted of two layers of TMDCs—specifically $MoSe_2$ and WSe_2—on top of a layer of hexagonal Boron Nitride (hBN). Using an atomic force microscope tip, we have managed to move TMDC monolayers on top of the atomically smooth surface of hBN; however, we are still attempting to rotate TMDC monolayers relative to each other. Currently, we are exploring the effects of relative crystal dimension with respect to rotation of the monolayers. We will optically study the heterostructures to probe the nature of momentum conservation across the interface as a function of crystal angle orientation using pump probe spectroscopy.

Gayathri Muthukumar
2019
Biological Sciences

Gayathri Muthukumar is a sophomore in Columbia College majoring in Biological Sciences. She does research at the Columbia University Medical Center. Her research project last year involved studying the role of microRNA dysregulation in schizophrenia and other psychiatric disorders in the lab of Dr. Joseph Gogos at the Neuroscience Department. Outside of her academic and research pursuits, she is also a dancer and Public Relations Head for Columbia Taal, a South Asian Fusion dance group on campus and was an educator for the Barnard-Columbia Peer Health Exchange program.

Faculty Adviser: Gogos, Joseph

The role of microRNA dysregulation in Schizophrenia

Humans with 22q11.2 microdeletion syndrome show behavioral and cognitive deficits, and are at a high risk of developing schizophrenia. In order to study this syndrome further, the Gogos lab engineered a mouse strain named *Df(16)A*$^{+/-}$, created by hemizygous chromosomal deficiency on mouse chromosome 16, spanning a segment syntenic to the 22q11.2 microdeletion. This mouse model has haploinsufficiency of the Dgcr8 gene, which is a part of the complex involved in microRNA processing. As a result, 19% of all the mature microRNA forms were downregulated in the pre-frontal cortex and 10% in the hippocampus of the *Df(16)A*$^{+/-}$mice. Expression of mir-185 (a specific microRNA) is downregulated by 70-80% in both the hippocampus and the pre-frontal cortex. The major downregulation in mir-185 levels in *Df(16)A*$^{+/-}$ mice results in the upregulation of its target gene, Mirta22 (miRNA target of the 22q11.2 microdeletion). Understanding how Mirta22 affects neuronal connectivity and eventually behavior and cognition is likely to provide more general insights into the contribution of miRNAs in psychiatric and neurodevelopmental disorders, and facilitate development of new treatments. Furthermore, normalizing Mirta22 levels in the *Df(16)A*$^{+/-}$ mice could reverse several of the behavioral and physiological abnormalities previously found in these mice. Here, we sought to investigate the role and function of Mirta22 in multiple levels. At first, cytoplasmic and nuclear extraction of samples for wild-type mice, Mirta22 knockout mice, *Df(16)A*$^{+/-}$ mice and *Df(16)A*$^{+/-}$*Mirta22*$^{+/-}$ mice was performed, followed by a Bradford assay and western blots with the Mirta22 primary antibody in order to study the Mirta22 protein levels in these mice. Our results could confirm its upregulation in the *Df(16)A*$^{+/-}$ mice and normalization in the *Df(16)A*$^{+/-}$*Mirta22*$^{+/-}$ mice. In addition, results from prior RNAseq tests indicate a difference in the levels of certain genes between wild-type mice and the Mirta22$^{+/-}$ knockout (KO) mice. Quantitative PCR (qPCR) was used to validate these differences. More specifically, qPCRs were done for 14 samples, 7 wild-type and 7 knockout, with the gene probes of interest: Kcnj11, Penk, Rtn4rl2, Chrm1, Sod3 and Bmp6. We were able to confirm changes in expression in Penk and Kcnj11. In a parallel investigation on proteomic analysis of the *Df(16)A*$^{+/-}$ mice, another potential target of the mir185 target, Ogt1 was found upregulated in a study done earlier this year in the protein level. Here, we sought to show that Ogt1 is overexpressed in the *Df(16)A*$^{+/-}$ mice at the mRNA level, as well. qPCR in *Df(16)A*$^{+/-}$ and WT confirmed this upregulation. Lastly, we set up a strategy to study Mirta22 protein function. To this end, HEK-293 cells were grown to study interaction of Mirta22 protein with other proteins. Mirta22 has two isoforms, a transmembrane form and a secreted form. Tagged ORF cDNA Clones were designed for both isoforms, using the FLAG-HA tag for the transmembrane isoform and the 6-His tag for the secreted isoform, to transfect the HEK cells. Assays performed after transfection, such as pull-down and tandem affinity purification, will help characterize the interaction partners of Mirta22.

Jessica Paek
2018
Psychology, Business Management

Jessica Paek is a junior in Columbia College majoring in psychology. As a research assistant at the Higgins Lab, she has conducted research in the social psychology fields of motivation, social support and emotion regulation. She also serves as a peer adviser for the psychology department, meeting with prospective psychology major students to discuss seminar courses, research opportunities and ways to be involved in the psychology community on campus.

Faculty Adviser: Higgins, E. Tory

The Influence of Regulatory Mode on Emotion Regulation

This research is among the first to explore the relationship between Regulatory Mode Theory and emotion regulation. Results demonstrate that those high on 'locomotion' motivation tend to engage in cognitive reappraisal, whereas those high on 'assessment' motivation tend to engage in expressive suppression.

Marcelina Puc
2019
Neuroscience and Behavior

Marcelina Puc is a sophomore in Columbia College majoring in Neuroscience and Behavior. Currently, she is working under Dr. Quadri studying the importance of actin via immunofluorescence in lung endothelial cells. She is interested in becoming a pediatric surgeon while conducting medical research on the side. Outside of lab work she is a part of Columbia's EMS corps, Vice President of the Columbia Science Review, an ISOP OL, and a member of the Global Recruitment Committee.

Faculty Adviser: Quadri, Sadiqa

Expression of Filamentous Actin in Human Lung Microvascular Cells

Endothelium creates a barrier, which is semi-permeable; it essentially creates separation between the blood and underlying tissue. This separation function is made possible by cell-cell and cell-matrix adhesions, which define, cell borders. Actin creates a matrix, which maintains the integrity of the cell shape; it also helps integral membranes stay anchored to the cell, in addition to responding to exterior changes to determine cell shape. Cortical actin connects organelles to cell-cell and cell-matrix adhesion complexes. Actin exists in two forms, globular actin, G-Actin (monomeric form) and filamentous actin, F-Actin. In order to view the structure and prominence of actin, immunofluorescence staining with Rhodamine phalloidin was used to see the distribution of F-Actin in the cell.

Samantha Rhoads
2018
Psychology

Samantha Rhoads is a junior in Columbia College and joined the lab in January, 2016. As a double major in psychology and sociology, Samantha explores both disciplines in conversation with each other. Samantha is interested in studying the adolescent experience and how educational institutions—and the social networks embedded with them—shape youth identities, self-concept, and outcomes. The school provides not only a domain that socializes children to a wealth of knowledge but also a medium to learn and internalize social norms. Thus, Samantha wants to explore these nuances to understand how schools can and should care for their students' mental health and interaction with the social world.

Faculty Adviser: Purdie Vaughns, Valerie

Empathic concern as a mediator for the relationship between social ties and political views

While people often assume they must feel a sense of closeness derived from admiration for an individual in order to be affected by that individual (Tropp, 2006), intergroup contact theory stipulates that the mere presence of others can mitigate a negative perception of a social group—reducing intergroup prejudice and conflict (Allport, 1954). In other words, mere acquaintanceship, not exclusively close relationships with members of an outgroup, can change one's perception of the outgroup. Furthermore, recent work in political science has found correlational evidence that increased social ties between members of some social groups (e.g., LGBT groups) is associated with more support for political policies that may affect those groups (e.g., same-sex marriage; Gelman, 2015). We investigated how non-Muslim students' acquaintances, friendships, and family ties to Muslims could reduce prejudice and intolerance toward Muslims, and how these ties would affect their views toward political policies that may impact Muslims. We established a hypothesis that it was not only having social relationships with Muslims that would correlate with more positive attitudes toward Muslims in general, but also that these social ties would increase empathy for Muslims as a group, leading to more support for political policies that may positively impact Muslims.

Under the framework of an ego network approach, we had eighty-five undergraduate participants name their Muslim acquaintances, friends, and family members. They reported their closeness to their named ties, their general attitudes toward Muslims, their knowledge about Islam, their views on political policies, and their basic demographic information. Five participants identified as Muslim, and thus were excluded from the analysis, yielding a final sample size of 80.

Using linear and multiple regression analyses, we found that the number of Muslim acquaintances participants named was correlated with more empathic concern for Muslims ($p=.022$). In addition, with a multiple regression, we found that the number of Muslim acquaintances was positively correlated with participants' views regarding the admittance of Syrian refugees into the United States ($p=.003$) as well as with participants' views toward closing schools for the Muslim holiday Eid al-Adha ($p=.003$)—even when we controlled for participants' political orientation. Using a Goodman mediation test, we discovered that empathic concern for Muslims mediated the relationship between number of Muslims acquaintances and views toward allowing Syrian refugees into the country ($p=.034$). In other words, number of acquaintances predicted empathy toward Muslims, which predicted views toward allowing Syrian refugees into the United States. We also found a mediation effect between total acquaintances, empathic concern for Muslims, and views toward closing schools for Eid al-Adha ($p=.040$).

The strong nature of the relationship between participants' number of Muslim acquaintances, empathy for Muslims, and positivity toward welcoming refugees/the closing of schools for Eid al-Adha is particularly remarkable as it implies that increased intergroup contact could theoretically produce a condition wherein contact with Muslims engenders a desire to admit more refugees from a majority-Muslim country into American society and integrate elements of Muslim culture into American tradition.

Hailey Riechelson
2017
Environmental Science, Modern Jewish Studies

Hailey Riechelson is a senior in the Jewish Theological Seminary/General Studies Dual B.A. program. She is an Environmental Science major with an interest in Geochemisry. She has been working at Columbia's Lamont-Doherty Earth Observatory campus using planktic foraminifera for paleotemperature and pH reconstructions. Other campus activities include the Columbia *Federalist*.

Faculty Adviser: Ducklow, Hugh

Boron Isotope Fractionation and Oceanic pH between the Holocene and the Last Glacial Maximum

Rapidly increasing atmospheric carbon dioxide (CO_2) necessitates understanding of past changes and projections of future concentration so we can predict the influence high CO_2 on Earth systems and chemical composition. A more complete description of the relationship between atmospheric concentration and ocean carbon uptake is needed to refine our understanding of the carbon cycle in the Earth system. pH is closely related to CO_2 flux between the ocean and atmosphere. It is known from ice core data that the atmospheric carbon dioxide concentration was lower than present at the Last Glacial Maximum (LGM), and recent studies have suggested that in certain areas, the ocean was more of a source of carbon dioxide to the atmosphere than in the present. Planktonic foraminifera (*Globigerinoides ruber*) from ocean sediment cores were analyzed to reconstruct ocean pH, temperature, and salinity from the LGM to the present in order to investigate how one particular location, the Walvis Ridge off of Africa's southwest coast behaved over this time span. Through geochemical analysis of the ratio between ^{11}B and ^{10}B incorporated into marine calcifiers, the water's pH can be reconstructed, given a known temperature and salinity. These contingent values were obtained via Mg/Ca and $\delta^{18}O$ analyses for Walvis Ridge from the Last Glacial Maximum to the present. Mg/Ca ratios reflect Mg substitution into foraminiferal calcite shell as a function of temperature, and $\delta^{18}O$ measures relative abundance of two stable oxygen isotopes, ^{18}O and ^{16}O, which can be used to find the salinity when temperature is known. Results indicate a fairly consistent pH, with the exception of a sharp decrease in pH at 3.9 ka, which could indicate upwelling.

Amelia Sawyers
2019
Biological Sciences

Amelia Sawyers is a biology major and a member of the Columbia College class of 2019. She is from New York City, but also attended boarding school in Massachusetts. Last summer, Amelia participated in the Summer Undergraduate Research Fellowship (SURF) and was a member of the Pon lab at the Columbia University Medical Center, which focuses on mitochondria and aging in yeast. SURF was not the first time Amelia researched in a lab; she spent two summers in the Vander Heiden lab at the Koch Center at MIT. On campus, Amelia is a member of Columbia College Student Ambassadors, Health Leads and the TCC At Your Service Program. During the 2017-2018 school year, Amelia will be studying Natural Sciences at Cambridge University through the Columbia College Oxbridge Scholars program.

Faculty Adviser: Pon, Liza

The Role of the MICOS Complex in the Mitochondrial DNA Checkpoint in Saccharomyces cerevisiae

Yeast lacking mitochondrial DNA (mtDNA), which are referred to as rho0 cells, typically arrest at the mtDNA inheritance checkpoint, between G1 and S phase, which relies on the classical DNA damage proteins Rad53p and Pif1p. The MICOS complex is known for maintaining the architecture of the mitochondrial inner membrane and forming mitochondrial contact sites between the inner and outer membranes. Due to this role in contact sites, it is also possible that MICOS acts as a sensor for mtDNA loss and can communicate this message outside the mitochondria. If so, MICOS could communicate loss of mtDNA to the DNA damage response pathway, thus activating it. By measuring the level of Pif1p phosphorylation, we can determine mtDNA checkpoint activation and investigate this potential role for MICOS. We deleted genes that code for MICOS components and YPR010C-A, an uncharacterized protein that physically interacts with MICOS, in *Saccharomyces cerevisiae* to observe the effects on Pif1p phosphorylation in rho0 cells. We found that Pif1p is phosphorylated in *YPR010C-AΔ*, *mic60Δ* and *mic26*Δ rho0 cells. However, we also found that Pif1p is phosphorylated in the wild-type cells that contain mtDNA. Thus, the DNA damage checkpoint was activated under our experimental conditions in an mtDNA-independent manner. Although our results are inconclusive, they nonetheless provide exciting insight into potential functions for MICOS.

Emerald Smith
2017
Environmental Chemistry

Emerald Smith is a senior in Columbia College and will be graduating this May with a degree in Environmental Chemistry. Her focus in this field has been carbon capture and storage, which is a main theme in her research this year. The project explores pore space access in peridotite rocks from the Semail Ophiolite in Oman as a limiting factor to in situ mineral carbonation in this rock. Emerald has competed on Columbia's D1 rowing team throughout all four years of her college career.

Faculty Adviser: Kelemen, Peter

Rate of Water Imbibition into Peridotite Rocks with Implications for Carbon Capture and Storage

Atmospheric CO_2 concentrations have been rising at unprecedented rates over the past century due to anthropogenic emissions from the burning of fossil fuels. Many researchers and policy makers are looking to carbon capture and storage as a realistic carbon mitigation action. Of the current methods of carbon storage, mineral carbonation is the most reliable and poses the smallest threat to surrounding ecosystems because it involves the chemical transformation of CO_2 into a stable mineral versus the storage of concentrated CO_2 in an isolated reservoir. Ophiolites, slabs of oceanic lithosphere deposited onto continents, are a promising potential geological sink for in situ mineral carbonation as a means of long term carbon storage. This study analyses the rate of water imbibition into samples of peridotite rock from the Samail Ophiolite, Sultanate of Oman as a limiting factor in accessibility of unreacted mantle rocks for in situ mineral carbonation. First, chemical and physical properties of the rocks, including mineral composition, extent of carbonation, and porosity, are determined using density measurements and imaging techniques. Then the rate of water uptake in these rock samples is measured through mass change measurements of partially submerged rocks over long time periods (weeks-months).

John Wilding
2017
Earth Science

John Wilding is a senior at Columbia College planning to graduate in May 2017 with a degree in Earth Science. His research interests include seismology, geochronology and environmental remediation. Outside of working at the Lamont-Doherty Earth Observatory, he enjoys reading, jazz and hiking. He has no plans for after graduation.

Faculty Adviser: Holtzman, Ben

Thermodynamic Modeling of the Lithosphere-Asthenosphere Boundary Beneath the Colorado Plateau

The dynamics of the temporal evolution of the lithosphere-asthenosphere boundary under regions of hot asthenosphere have not been widely studied. Asthenospheric corrosion is a proposed mechanism for boundary evolution, in which the thermal and chemical potential gradients across the lithosphere-asthenosphere boundary cause the boundary to propagate upwards, thinning the lithosphere. Tomographic imaging and encroaching volcanism indicate that lithospheric thinning by hot asthenosphere may be occurring underneath the margins of the Colorado Plateau. Pre-established seismic velocity profiles of the Colorado Plateau and the nearby Basin and Range, as well as temperature profiles established from thermobarometric testing of local volcanic fields, are used as constraints on forward thermodynamic models of the underlying LAB system. A new software package, the Very Broadband Rheology calculator, is employed to produce shear wave velocity models from input forward thermodynamic models in order to quantify misfit and ultimately determine a best-fitting structure. Models with low misfit have been produced corresponding to several shear wave velocity models. Two-phase flow calculations are undertaken to model the temporal evolution of the LAB, elucidating the magnitude and timescale of lithospheric alteration under the given seismic and geochemical constraints.

Karen Xia
2018
Computer Science and Statistics

Karen Xia is a junior in Columbia College studying Computer Science-Statistics and Environmental Biology. She investigates particulate matter and aerosol optical depth in the atmosphere in Indian urban centers. She has analyzed spatial and temporal trends in air quality, utilizing a global chemical transport model (GEOS-Chem) to model aerosol behavior in India over the past decade. Her work in trend analysis and modeling aims to better understand and describe the Indian air quality issue, with the ultimate goal of adding a voice to public health and policy decisions surrounding air quality. On campus, she can be found helping out at Columbia EcoReps' various sustainability events, hosting residential hall events as a Resident Adviser or interviewing prospective undergraduate students for the Office of Undergraduate Admissions.

Faculty Adviser: Westervelt, Daniel

Analyzing and Modeling Spatio-temporal Trends and Variability of Particulate Matter (PM) and Aerosol Optical Depth (AOD) over Urban Hotspots in India

Air quality in the developing world has decreased dramatically in the recent past, because of a combination of largely anthropogenic sources. One of the major consequences of this change in air quality is a corresponding increase in mortality in large urban centers. Particulate matter (PM) with diameter of less than 2.5 microns, a major contributor to poor air quality, is especially detrimental to human health. India, ranked in the top ten most air polluted countries based on particulate matter concentration, has experienced rapid increases in air pollution in the past decade, in part due to its agricultural burning practices, traffic congestion, and overall population increase. Therefore, it is imperative to study the specific particulate matter in the atmosphere that contribute most to harming human health, and better understand the severity of this issue in India.

In this study, we analyze spatial and temporal trends and variability in PM and aerosol optical depth (AOD) measurements over the past decade, determine correlation coefficients between PM and AOD, and model air quality using a global chemical transport model, GEOS-Chem, to simulate the air quality above and around India. We found that within India, AOD and PM are not always completely reliable indicators of air quality for each other. The GEOS-Chem model, however, shows a strong correlation between AOD and PM. We also found that the GEOS-Chem model is biased low on PM over India, which can be attributed to coarser resolution data (compared with actual ground-based measurements), underestimated PM in urban areas, and most importantly, incomplete emissions inventories. Ultimately, the goal of this research is to provide tangible, quantitative evidence that can support proposed policy solutions to improve air quality in India, and eventually, globally.