Fall 2015 Features

Your Fly’s Down: Drosophila Reproductive Systems

Keeping an Open Mind:

How Perception is Historically Decontextualized

Rethinking Urban Land Use and Transportation Planning

The Heart of the Issue:

Understanding Aortic Valve Disease Decisions

Can’t Get You Outta My Head: What Makes Songs Catchy

The Way to Someone’s Heart?
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Although reproduction and development are vital areas of genetic research, for fruit flies, one of the most widely used model organisms, several reproductive unknowns still exist. Allie Cohen, a senior in the College of Agriculture and Life Sciences, is currently attempting to fill in some of those missing pieces.

Cohen first became involved in research the summer before her junior year of high school. “I ended up just loving the lab that I worked in. Fruit flies, it turns out, are a great love of mine,” she says with a laugh. Cohen was then accepted into the Rawlings Cornell Presidential Research Scholars Program (RCPRS) and, through her old mentor’s recommendations, found another fantastic lab mentor at Cornell. She is a researcher working with Dr. Mariana Wolfner in the Wolfner Lab in the Biotechnology Building, a part of the department of Molecular Biology and Genetics, and her two current projects stem from the research she started her freshman year and finished last semester: the study of the mating plug in female fruit flies.

The mating plug, which resides in the uterus of fruit flies, is the source of the polymerization of seminal fluid proteins after mating. Cohen’s work explored the mating plug’s full function. “Of course, it’s genetics,” Cohen says. “If you want to understand what something does, you try to take it away.” Cohen’s lab isolated and focused on the key gene PEBme, a product of the male fruit fly’s ejaculatory bulb organ. After knocking PEBme down in the flies, the lab found that the mating plug takes three distinct forms: normal, unpolimerized, or reduced. Knocking down PEBme also affects fertility and fecundity. Interestingly, it prevents the ejaculate from staying in females, which causes mating fruit flies to stick together. Such cases are labeled as the ‘stuck’ phenotype; however, this phenotype is only expressed variably. This phenomenon is what spurred Cohen’s current research: determining whether there is a correlation between the stuck phenotype, the level of polymerization of the mating plug, and the level of knock down of PEBme in supposed genetically identical fruit flies.

Cohen performed an interrupted mating experiment and observed that virgin fruit flies and mated fruit flies had ejaculatory bulbs of differing shapes and sizes. She explains, “I looked in the literature and nobody had really described this before, and it seemed to me like there was an inflation of the ejaculatory bulb from virgin fly to mated fly.” Cohen then wondered whether the bulb would decompress, so now she tracks the inflation, deflation, and then re-inflation and re-deflation of the bulb over the course of several different matings. So far, this has yielded a very predictable pattern.

Cohen’s next step is to understand what stimuli lead to the swelling of the ejaculatory bulb, because males only experience the response exclusively for females. She asks, “What signal do they pick up about the female that causes the ejaculatory bulb to swell? Do they see her? Do they smell pheromones? So we’re going to get eyeless flies, flies that have problems with olfaction, and see how that affects this re-inflation and deflation process.”

Cohen, a Biology and Society major, plans to pursue law school upon graduation along with a master’s degree in public health. Currently, she is the Director of the Peer Advisory Program for RCPRS, where she is paying forward all of the excellent research mentorship she received in the past by helping freshmen find research of their own. Ultimately, when it comes to research, Cohen enjoys the creativity of solving a problem. She says, “Sometimes, you find something you didn’t expect and try to figure out what to do with it, and other times, you hit a wall and say, ‘Okay, everything that I thought before was wrong. How do I approach the exact same thing from a totally different way?’ It’s fun doing research.”
Decoupling supply and demand in the power grid has the potential to significantly increase the efficiency of electricity production and transmission. In order to reduce the maximum load on the power grid at any given time, power demand must be distributed more uniformly over time, and one critical player in this energy distribution game is thermal energy storage.

Thermal energy storage, often directly used in heating and cooling applications for residential and commercial buildings, can be stored as two forms: sensible heat and latent heat. Sensible heat storage involves the heating or cooling of a storage medium, like a block of metal, to result in a temperature change. On the other hand, latent heat storage minimizes temperature changes and stores heat in the form of a phase change. A phase change, for example, from liquid to solid results in a significant discharge of heat with a minimal change in temperature. Latent heat storage allows for increased efficiency in the power grid by charging up during off-peak hours at night and discharging useful energy during peak daytime hours.

Will Gregg, a Senior Chemical Engineering major, works on these problems in the Cornell Energy Institute with Professor Jefferson Tester and PhD student Mitchell Ishmael. Working at the interface of energy storage and thermodynamics, Gregg initially researched the behavior of supercritical fluids around the critical point by using a specific flow calorimeter to measure the thermo-physical properties of carbon dioxide and binary mixtures. (Because the properties of supercritical fluids cause them to behave erratically with respect to pressure and temperature near the critical point, the selection of a flow calorimeter was crucial to his research. Other calorimeter variants would have been less effective in addressing this complication.) Ultimately, Gregg’s team was unable to find sufficient data on the behavior of mixtures of carbon dioxide and organic solvents near the critical point.

Gregg now works on a related but broader project with Ishmael centering on the application of latent heat storage to improve power grid efficiency. Gregg is primarily involved in the devising of novel encapsulation methods for manufacturing these spheres consistently as well as deciding which materials to use. He also applies computational modeling techniques to optimally size a bench-scale heat transfer loop that will later be constructed for data collection in the lab.

When he’s not in the lab, Gregg is a Co-Chair of Engineering Peer Advising, President of the Cornell University Wind Ensemble, a teaching assistant for Introduction to Chemical Engineering, and is actively involved in Cornell’s chapter of the American Institute of Chemical Engineers. His research is supported by The Hunter R. Rawlings III Cornell Presidential Research Scholars program, for which he is a member of the Student Advisory Board. After graduation, he will join the Securities Division of Goldman Sachs as a strategist for the commodities trading desk. In this capacity, he will help institutional clients in the energy industry manage risk and finance capital investments that improve the efficiency and sustainability of their operations. He firmly believes “this is a great way to play a role in the direction taken by the commodities industry moving forward, which will be instrumental in determining the future of energy.”
A Race to Save the Orange by Detection

By Alisa Lee '17

If you have ever drank a cup of Florida orange juice, you might have noticed its sour and/or bitter taste. This bitter taste is due to Huanglongbing (HLB), often referred to as citrus greening disease, which has rapidly spread throughout Florida ever since its arrival in the United States in the early 2000s. Although the disease poses no apparent threat to humans or animals, HLB is fatal to citrus trees. Once a tree becomes infected, there is no cure and it will die from the infection. It has been predicted that unless a cure is found, there will be no citrus whatsoever growing in Florida. HLB destroys the production, appearance, and value of citrus trees and has currently caused more than $4 billion in revenue loss. If a solution is not found, more than 75,000 jobs will be lost.

One of the leading investigations in this issue is being conducted in Cornell University's Cilia Laboratory in the Boyce Thompson Institute for Plant Research. The Cilia group is working to develop an early detection method by identifying the proteins generated by citrus trees soon after infection. It is thought that the disease is caused by the bacterium C. Liberibacter Asiaticus, which is spread between trees via a lice-like insect called the Asian citrus psyllid, or Diaphorina citri. The diagnosis of HLB infected trees can be difficult, as symptoms may not be visible for more than a year after the tree has become infected; this is one of the major reasons for its continuous spreading worldwide. Current detection strategies rely on real-time, quantitative polymerase chain reaction (PCR) methods to detect the infected trees. The problem with the quantitative PCR analysis is that the detector will not distinguish the infected trees from regular citrus trees until twenty-five weeks after the initial infection. A new diagnosis method for HLB is critically needed to stop the spread of the disease.

As a senior chemistry and chemical biology major in the College of Arts and Sciences, Jared Mohr strives to solve this problem in the Cilia Laboratory. In the lab, Mohr spends most of his time developing a diagnostic model for proteomic profiles of the HLB-positive trees. For his project, the protein profiles of healthy and HLB infected plants are collected every two weeks using high resolution mass spectrometry and were analyzed for different protein expression. After data analysis, Mohr has constructed a list of twenty to thirty specific protein peptides that can differentiate between the control and infected samples at 85 – 90% detection level. This diagnostic model can detect the disease with significantly higher accuracy and six to eight weeks earlier post-infection than the current QPCR method, which needs at least twenty-five weeks for reliable results.

The next step for Mohr’s research is the Selective Reaction Monitoring (SRM) mass spectrometry assay, which can target specific proteins to confirm the detection level and check for accuracy before developing a detector for small quantities of citrus trees. This new detection method will bring us one step closer to stopping the disease and saving the citrus trees.

Mohr received the 2015 Frank L. Howard Undergraduate Research Fellowship from the American Phytopathological Society (APS). This award, given to a single undergraduate each year, has funded Mohr's work on the early detection of HLB. He also had the opportunity to present his work this summer at the APS meeting in Pasadena, California. He enjoys discussing ongoing scientific issues with peers and presenting his laboratory work.

When asked about his experience in research, Mohr said that “it’s like puzzle solving: finding what's significant and its applicability.” Among other skills picked up in lab, he has become proficient in large scale data analysis and bioinformatics. Planning for the future, Mohr would like to pursue a PhD in chemistry and apply the findings of his research to the world. Aside from his research, Mohr is an active member of the Cornell ChemE Car team, and enjoys playing crumpets.

This research is being conducted in the Boyce Thompson Institute for Plant Research (BTI) under the supervision of Dr. Michelle Cilia. To contact the researcher, email jpm369@cornell.edu.
In the midst of extreme violence and destruction in places like Afghanistan, Iraq, and Syria, the war torn reality is exceptionally different in comparison to peaceful and economically thriving Western countries like the United States, argues senior Anthropology and Archeology major Anjum Malik ‘16. Through gauging people’s reactions about iconoclastic events such as the destruction of the Bamiyan Buddha statues by the Taliban and the desolation of the Mosul Museum and Palmyra by ISIS, Malik researches the ways in which we interpret the various media and news coverage for these incidents, especially when we are unfamiliar with the historical and sociocultural context of the portrayed events. Malik has determined that people’s perceptions of heritage destruction and iconoclasm tend to be “historically decontextualized depending on an individual’s geographical and sociocultural proximity to the event in question.” Thus, the goal of her research is to instill the idea that when we look at news items concerning heritage destruction, we need to understand that the topic is more nuanced and sensitive than the media portrays it to be.

Malik began searching for a thesis topic when she was a freshman and formulated this research project during her semester abroad at the University College London in the spring semester of 2015. Early on in the process, Malik decided that she wanted to focus on an archeological issue that was relevant to today’s world. Speaking with her professors and advisors about her ideas was a crucial factor in streamlining her interests to concentrate on a specific issue. Her thesis advisor, Dr. Frederic Gleach, has been instrumental in helping her through the whole research procedure thus far. In fact, his assistance is “of such value that [Malik] can’t even quantify it.”

Last year, Malik began her project with a pilot study in the United Kingdom in order to get a sense of how to approach this topic. Over the summer, she conducted research in Washington D.C. and New York City where she interviewed different museum curators and lawyers who worked on cultural and heritage repatriation. By speaking to people directly involved in archeology and museum studies, she collected data on the potentially crucial role that museums could play in elucidating the current situation in both Afghanistan and Iraq to the public. She also spoke with students both in the US and abroad about these issues through personal, informal conversations in order to gauge their reactions. Another medium of data she used was the comment sections of news articles and public Internet forums where people discuss their opinions and reactions to recent heritage destruction events. Throughout her data collection, Malik felt it was her responsibility as a researcher to stay open-minded and make people feel as comfortable as possible to voice their opinions in a non-judgmental setting. This process taught her to be more open to looking at her research from different perspectives.

The take away message from her research thus far is that “people should take what the media gives them with a pinch of salt” and that people are quick to make conclusions based off of one particular perspective without considering the greater context. Therefore, Malik argues that in order to understand events of heritage iconoclasm and vandalism, it’s necessary to interpret the events within the context and environment in which they are occurring. Malik’s favorite aspect of research is the fact that this topic interests her from both a scholarly and personal aspect and it allows her to share her passion with a wider audience.

Malik hopes to use the deduction, analysis, and overall research skills she has developed in her future career as an archeologist. Besides devoting her time to research, Malik is also involved in the Cornell Anthropology Exchange, the Cornell Marching Band, the Cornell Annual Fund, and the Jonathan and Jeannette Rosen Cuneiform Tablet Lab.

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If you’re like most Americans, your only notion of a religious procession probably draws heavily from “The Godfather.” Yet what seems to be an archaic amalgamation of altar boys, white robes, and holy water holds insights into the nature of labor, spirituality, and Italian culture. Emma Ianni, a junior Classics major and Italian native, hopes to specifically examine four such Italian religious processions: the Festa de Gigli, the Varia, the Macchina di Santa Rosa, and the Discesa dei Candelieri. The four processions celebrate various local religious events, including the feast days of patron saints and the Virgin Mary’s ascension to heaven.

Ianni drew upon a wide array of experiences in choosing to study the processions of interest, notably her Italian heritage and passion for history and the classics. While skimming the online Italian publication, Internazionale, Ianni learned that UNESCO has awarded the four processions the distinction of “Intangible Cultural Heritage” sites. As she began to research the processions’ decorated history and continued cultural significance, she wondered how these traditions had succeeded in remaining relevant in the modern, liberal Italy she calls home. In accord with her field of study, Ianni turned to the classics in order to better place these rituals in the timeline of western history and to analyze their cultural ramifications. Ianni enlisted the help of her academic advisor, Associate Professor Michael Fontaine, to draft her research proposal and soon found herself crafting a comparative study of processions in Italy, ancient Greece, and Rome.

Though Ianni has only been conducting her research for one semester, she has already outlined many of her project’s goals. Regarding the four modern processions, Ianni is interested in studying the relationship between craftsmanship and religiosity. Ianni is also curious about the social significance of manual labor. Specifically, she hopes to investigate whether the physical labor and artisanship invested in creating the obelisks, towers, and other structures carried in the processions hold some sort of intrinsic value or if this value is simply derived from the Catholicism in which the events are rooted. Altogether, the research will examine the unique ability of these religious processions to create a sense of community and sustain social ties. As the processions are held during several summer festivals, Ianni plans to visit the Southern Italian towns in which they occur next summer.

In the meantime, Ianni will be grappling with the classical component of her comparative study: processions and spectacles of ancient Rome and Greece. In ancient Greek society processions were means of celebrating religious festivals or honoring Olympic victors. Ianni plans on analyzing these customs through the era’s rich poetry and vase paintings. In contrast, the processions of ancient Rome were spectacles that celebrated victors of key battles. In this Roman component, Ianni will synthesize and elaborate on the work of scholars, such as Mary Beard, to explore how the battle reenactments, masks, and statues of Roman processions resulted in blurring of the lines between the public and the artistic representation they had created.

In the short time since she began her research project, Ianni has already developed several skills, including effective reading of dense primary sources and the ability to make intertextual references. She has enjoyed the classics since high school. She also cherishes the small class size and focus on interpretive skills in classics courses at Cornell. After developing this research into an honors thesis and a documentary or newspaper article for an Italian audience, Ianni hopes to further her studies in the classics in graduate school. On campus, she is also an active member of the national honor fraternity, Phi Sigma Pi, and a writer for the Cornell Daily Sun.
At the center of the universal machinery of translation – the process by which protein is made through mRNA code – is the ribosome, a small granule of protein and RNA responsible for building the vast array of proteins that make up organisms. As it is essential for protein synthesis, the ribosome’s mechanism of action is similar in most living organisms; however, our knowledge of the intricacies of translation is still incomplete. The ribosome is made of dozens of proteins and a few ribosomal RNA molecules, yet the functions of many of these ribosomal components have not been thoroughly researched. One such protein, known as 60S ribosomal protein L8 (RPL8), may have a regulatory role in translation, and it is this particular protein that Holly Deng is focused on learning more about.

Deng, a junior majoring in Biology and Society in the College of Human Ecology, has been conducting molecular biology research in the Qian Lab since her freshman spring semester. She conducts experiments that knockout the RPL8 protein from the ribosomes of cells, which is then followed by various analysis to understand the effects of the knockout compared to the normal cell’s ribosome translation abilities. These experiments first involve a virus infection and then plasmid transfection, which introduces two luciferase (bioluminescence) genes into the cells, followed by testing for expression of these genes. The luciferase and CCK8 assay has proved to be challenging to provide “good” numbers, with “the effects of knocking out [not] always showing what we’ve been expecting,” says Deng. As a result, she continues to optimize the conditions of her experiment. Other techniques Deng use include Western blotting, measuring protein concentrations, and cell-death assays, all of which allow her to assess how cell function changes with the knockout.

In the long term, Deng hopes to improve her experimental procedure and better characterize the function of RPL8. She explains, “This is one of many projects looking at something that hasn’t really been looked at... [RPL8] exists in human cells, and it could apply to any disease in which translation regulation goes wrong.” Deng notes that though the research is still in its early stages, it could eventually become applicable to treating diseases such as cancer because “in the bigger picture, a lot of diseases are because of translation not being tightly controlled.”

Though Deng's research experiences have helped her build skills such as scheduling, being detail-oriented, and thinking critically, one of her favorite aspects of working in a lab is building connections with other researchers. Her lab is mostly made up of postdoctoral researchers, and Deng enjoys working with them because they provide “a good balance of assistance and independence.” Every year, the lab has a summer picnic at a local park and a Christmas gift exchange, which is a fun way for the lab to bond.

As a Rawlings Research Scholar, Deng first met her current mentor, Dr. Shu-Bing Qian, after searching through the Human Ecology faculty research pages. She later contacted him, had a brief interview, and began working in the lab during the spring semester of her freshman year. The Rawlings Program provided her with funding to stay at Cornell the following summer, which was an experience that gave Deng a taste of what a career in research is like. The opportunity to do research over a summer is invaluable, as Deng notes it is a great way to see and learn multiple-day experiments while finding your place within the lab. Deng continues to work in the Qian Lab now.

Outside of the lab, Deng is a member of the Cornell International Affairs Society, Alpha Phi Omega, Cornell Taiwanese American Society, on the student advisory board of the Rawlings Presidential Research Scholars Program, and works in the Career Exploration Center for Human Ecology. She plans to study abroad in Geneva, Switzerland through the Boston University Public Health Internship Program next spring, and hopes to eventually work in the health care industry.

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Patrick Braga ’17, a Rawlings Cornell Presidential Research Scholar, is in his fourth year in the College of Architecture, Art, and Planning and the College of Arts & Sciences. He is pursuing degrees in Urban and Regional Studies and Music. Last summer, with the support of Rawlings funding, Braga worked with the Boston Cyclists Union to research the sociopolitical processes surrounding bicycle infrastructure across income levels. He has utilized his experiences by writing books and exploring methods of improvement in infrastructure and relating fields.

Braga’s research at the Boston Cyclists Union culminated in his forthcoming second book, Bicycling in Boston, wherein he constructs an argument for why the law should adopt a more refined lens for regulating and setting expectations for bicyclist behavior. He expressed in this book that treating bicycles with the same standards as motor vehicles is not always safe. For example, dangerous behaviors like riding across traffic become harder to correct when the law does not reflect the physical nuances of bicycling. Additionally, he reflected on how the streets of Boston are over-engineered, when simpler, safer, and more effective options are often available. He explained that the presence of two-way intersections contributes to several issues that could be resolved or diminished by the implementation of dual roundabouts or a combination of roundabouts and stop signs. This would reduce air and noise pollution, increase predictability, and make crossing the intersection safer for everyone using the road.

In his planned third book, Building The Marvelous City, Braga hopes to explore aspects of what he calls the “long twentieth century” of architecture and city planning in Rio de Janeiro, a time period marked by an incessant search for modern architectural and national identities. According to Braga, this time period runs from around 1888, when slavery was abolished, to 2016, when Rio de Janeiro will host the Olympics. When explaining land-use legislation in Brazil, he described the lack of focus on how a new building might fit into a neighborhood as “blind-blanket zoning.” As a contrast, form-based zoning regulations are a genre of zoning codes which developed in the United States which also have Brazilian cultural precedents.

For instance, a legal decree from 1811 regulates building typologies for a neighborhood west of downtown Rio and articulates a physical vision of urban design similarly to what form-based codes do—take into account how the physical form of a building may best respond to its surroundings. Though these have not quite taken hold in Brazilian urban policy, Braga explained that form-based methods could be used in Rio de Janeiro to shape more sustainable and attractive urban spaces. He was able to present some of these findings when he discussed ideas of cultural modernity and land-use planning at the Inaugural Cornell Geospatial Forum in 2014 and the Cornell Undergraduate Research Board’s 2015 Humanities Showcase.

In addition to these research projects, Braga has also investigated the social and land use impacts on low-income communities due to the cable car implementation in Rio de Janeiro’s slums. He presented this work last spring at the 23rd Congress for New Urbanism. As a sophomore, he spoke at the same conference about misapplied notions of walkability in master-planned communities in Florida.

Aside from involvement in his research projects, Braga attended an international debate tournament in Morocco as a sophomore, and his experience was featured in the Sarasota Herald-Tribune. At Cornell, he is the president of Contrapunkt, the undergraduate composers’ organization. He has presented scenes of his first opera, which premieres in December, at Contrapunkt concerts, among other works. Ithaca Mayor Svante Myrick has also appointed him to serve as a voting member of the City of Ithaca Bicycle/Pedestrian Advisory Council. Just recently, Braga was selected to be a member of the Student Assembly Infrastructure Fund Committee, which helps support campus infrastructure improvement projects. Looking forward, he ultimately wants to work toward a doctoral degree in urban planning or a related discipline.

Braga thanks Professors Jennifer Minner, Thomas Campanella, John Forester, and Michael Manville for their mentorship and support.

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Reproductive History Reveals a Woman’s Underlying Health
By Eugenia Xiao ’18

Maternal health is never just about the mother. The World Health Organization (WHO) defines maternal health as “the health of women during pregnancy, childbirth and the postpartum period.” While these are focus areas in maternal health research, the subject entwines other aspects of community health such as the fate of the mother’s unborn child, her family, and her community. Recognizing this in 1996, the Danish government established the National Birth Cohort (DNBC) which aimed to track reproductive health histories for 100,000 women. Using DNBC data along with hospital registers, Shannon Chen, a senior biological sciences major concentrating in nutrition in the College of Arts and Sciences, began conducting research on the association between live births and maternal risk of hypertension and cardiovascular disease in 90,810 women.

The Denmark hospital system maintains population-based registers on diseases, demographics and social conditions recorded in hospital settings, and links those individuals by a common ID number. Chen began working with this data as a research assistant in the second semester of her freshman year with Helene Kirkegaard, a PhD student at the time for Professor of Nutrition Dr. Kathleen Rasmussen. Using individual ID numbers, she combined abortion register information from 1973, birth information from the Medical Birth Registry, and relevant information from the DNBC to construct a full reproductive history for 91,329 women.

“It’s amazing to trace one woman’s entire reproductive history with data—it’s never been done before. This compilation is not only going to be used in my research, but others' as well,” Chen said.

In the fall semester of her sophomore year, Chen synthesized her own research using the data that she created as a research assistant. She sought to examine how the state and history of pregnancy affects one’s likelihood of having cardiovascular disease (CVD).

“During pregnancy, one’s body is in a hyper-inflammatory state resembling conditions of cardiovascular disease. Your lipids go up, and your heart rate goes up,” Chen explained.

Chen’s univariate data analysis on CVD and the number of live births has produced a J-shaped trend. At zero live births, there is a high risk of CVD. This risk decreases at one to two prior live births and increases at four or more prior live births. Such a trend demonstrates an associational relationship between pregnancy and CVD.

“It is possible that pregnancy increases the risk of CVD. Furthermore, pregnancy can reveal the underlying CVD problems a woman already might have had,” Chen explained.

Further answers can arise depending on an individual’s background, but Chen’s data shows that the frequency of a woman being pregnant affects her cardiovascular health. While Chen is focusing her research on the association between CVD and the number of live births, she is also adjusting her data for adverse birth outcomes along with pre-pregnancy BMI.

Chen’s research brought her to Denmark this past summer, where she interacted with those she worked with remotely at Cornell. She witnessed the Danish healthcare system firsthand by conversing with the OB/GYN and midwives in a hospital setting. She observed that despite extensive measures taken in Denmark’s hospitals to monitor maternal health, staff still have a strong incentive for improvement. These interactions allowed her to glimpse into their attitudes towards maternal health.

“The results [of reproductive history data analyses] have broader consequences there. Danish women are more likely to plan their pregnancies and are typically pregnant at later ages,” Chen said.

Chen thoroughly enjoys her research and the independence she has gained through time management skills. In addition, she now has greater knowledge about epidemiology and expertise in the statistical software STATA. In Spring 2016, she will present her findings at the Seniors Expo for Hunter R. Rawlings III Cornell Presidential Research Scholars.

Outside of research, Chen is a Senior Advisor of Cornell’s Illuminations Dance Troupe. She also serves as Director of Internal Affairs in Cornell Asian Pacific Islander Student Union, where she coordinates and facilitates networking events between Asian cultural organizations. She enjoys catching up on John Green novels and listening to Pentatonix in her spare time.

This research is being conducted with Dr. Kathleen Rasmussen.
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How many times have you seen a resume that looked a little too perfect? Or how many times have you contemplated self-reporting an inaccuracy when you had something to gain? What if there was a way to encourage honesty in online platforms?

For Chris Traver, a Junior Information Science major in the College of Agriculture and Life Sciences, this is exactly the question in which he is interested. Traver first became interested in research in the field of online deception through a course taught by emeritus professor Jeff Hancock, called "Deception in the Networked Age." The course focused on different types of online deception, how to detect it, as well as how to properly deceive others online. Through this course, Traver was exposed to many different publications from experts in the different subdisciplines of deception, becoming increasingly interested in the field. By the end of the course, Traver had become so invested in the field that he ended up pursuing the topic of his final project, the effect of images of eye primes on online deception, in further research with Professor Hancock. Since then, Traver has worked with Hancock in the Cornell Social Media lab in the Department of Communications.

Eye-priming, the focus of Traver’s work, has to do with the effect of placing an image of an eye on a screen during a task in which the participant must either roll a die and report the number rolled, or flip a coin six times and report the number of heads. There is a higher monetary incentive for a higher number, the idea being that if the participant subconsciously feels as though they are being watched (i.e., by the image of the eye), they will report results more honestly than if they were exposed to a picture of flowers instead. Traver’s findings backed up his hypothesis, showing that participants exposed to an image of eyes were overall less deceptive than those who were showed a picture of flowers.

The implications of his work could potentially be extremely helpful to any person trying to minimize deceptiveness in a situation where participants have an incentive to be dishonest. For example, for cases in which an individual could “cheat by self-reporting,” in situations such as exams, taxes or résumes. This could help facilitate a more honest environment in locations such as college campuses where high rates of deception exist. In the future, Traver hopes to expand his research study to include variables such as including a whole face instead of just an eye, or a group of eyes, or increasing incentivization, to see the effect on deception.

As part of the Hunter R. Rawlings III Presidential Research Scholars program, Traver knew coming into Cornell that he would be getting involved with research in some form. What was more unexpected is the extent to which he has come to enjoy it, as he is now looking toward pursuing a Ph.D. or a master’s degree in the field.

Traver encourages all interested students to explore doing research: “I really enjoy research because it is a great way to explore your passions and learn in a different way than through a traditional classroom setting,” he said. “Being able to come up with your own research questions and then putting them to the test is very rewarding when your results turn out to be what you expected.”

In his spare time when he is not doing research, Traver acts as the marketing chair for Guiding Eyes for the Blind and is also a brother of Pi Kappa Alpha.

Stephanie Wisner ’16 is a student in the College of Arts and Sciences. She can be reached at saw297@cornell.edu.
The Heart of the Issue: Understanding Aortic Valve Disease
By Emma Dietz '18

There is no doubt that the work of the human heart is impressive. Though it’s only the size of your fist, it beats on average 100,000 a day, sending 2,000 gallons of blood pumping through your body. But, as we grow older, so too do our hearts, and with aging comes a whole host of diseases that can affect the function of the organ.

One disease that affects both the young and old alike is aortic valve calcification. During the course of this disease, calcium deposits form on the aortic valve of the heart, causing the valve to thicken and grow hard. Eventually, this can lead to complications such as aortic valve stenosis—the reduction of blood flow through the aortic valve. Though the disease alone does not cause significant problems, a valve with this affliction will inevitably need to be replaced as the disease progresses.

So why not just treat the disease before there is a need for replacement surgery? The answer is simple: there is no known treatment. This is where Andrea Lo, a sophomore in the College of Human Ecology at Cornell University, focuses her research. Lo works at the Butcher Lab in the Department of Biomedical Engineering and studies cardiovascular development. The overarching goal of the lab is to help develop therapies to combat the progression of heart diseases such as aortic valve calcification.

The Butcher Lab is a center for innovation and discovery. To further their study of the progression of aortic valve disease, the lab has moved beyond the usage of classic 2D cell culture and into the realm of 3D cell culture. The 3D culture system uses a collagen hydrogel, a Jell-O like substance, to suspend cells. This structure allows for a closer approximation of how an actual heart valve functions. The cells come from either pigs or humans; depending on the specific project for which they are used. Within the substrate, there exist two different types of cells—endothelial cells and interstitial cells. Endothelial cells line the outside to protect the interstitial cells while interstitial cells make up the extracellular scaffolding that provides the mechanical characteristics and allow for the unique function of the aortic valve. These interstitial cells have a tendency to undergo osteogenesis, or the calcification of the valve.

As a current Rawlings Presidential Research Scholar, Lo spent much of her past year learning about aortic valve calcification, and obtaining valuable background knowledge before moving ahead to plan her own research project. Now, she has just begun her own study under the supervision of Dr. Butcher.

For her research project this upcoming year, Lo is focused on examining the ability of cells to uptake a specific type of particle called hydroxyapatite. These particles are the building blocks of bone tissue. Yet they are found in diseased aortic valves. It is thought that these particles are deposited in the aortic valves by certain transporter proteins. Once deposited, it is possible that the aortic valve cells could potentially absorb them. The deposition of these particles is closely tied to aortic valve calcification.

“The goal of this innovative research is to try and discover a way to prevent and treat aortic valve calcification, eliminating the need for expensive surgeries and years of unnecessary suffering.”

In her 3D cultures, Lo uses co-cultures of Valve Interstitial Cells (VICs) and Valve Epithelial Cells (VECs) in order to study how cell-to-cell interactions might affect the progression of the disease, and also how it might influence uptake of hydroxyapatite particles. She also uses a bioreactor to study how cyclic and static strains, two different mechanical stresses, influence aortic valve calcification. The cyclic strain setting allows for observations about how strain might affect a normal heart, while the static strain can provide information about the ways in which strain might affect an already diseased heart.

The goal of this innovative research is to try and discover a way to prevent and treat aortic valve calcification, eliminating the need for expensive surgeries and years of unnecessary suffering. Outside the lab, Lo continues to be involved in the sciences, dedicating her time as a tutor and as a study group leader.

Emma Dietz ’18 is an environmental science major in the College of Agriculture and Life Sciences. She can be reached at erd37@cornell.edu.
In today's technological age, a lack of resources is no longer the limit for scientists wishing to expand their research into unexplored territory. Consider, for example, veterinary medicine. Research solely focused on animal treatment is uncommon, and the multitude of discoveries yet to be made has inspired a surge of studies in animal science and relating fields. Cornell University, and specifically the Baker Institute for Animal Health, is working toward advancements in these fields through students like senior Ivanna Bihun, who is studying the therapeutic use of stem cells for equine brain and central nervous system injuries in Dr. Gerlinde Van de Walle's lab.

Bihun is majoring in Biological Sciences in the College of Agriculture and Life Sciences with a minor in Philosophy. When Bihun transferred to Cornell her sophomore year, she had no prior experience in the laboratory setting. She, like many incoming students, joined the Cornell Undergraduate Research Board and searched extensively for potential research opportunities. Bihun found the Van de Walle lab as a junior and is now working on an honors thesis with the help of her mentor Rebecca Harman.

"Horses often lack proper treatment for neurological ailments and disorders, so such diagnoses can severely cripple the remainder of their lives and leave only the option of euthanasia. Bihun’s research is specifically intended for improving and curing animal ailments."

As part of the Baker Institute for Animal Health, the Van de Walle lab conducts research on several different organisms, including horses. Equine medicine is a relatively new and consequently understudied field, so literature to guide the research process is also limited. Horses often lack proper treatment for neurological ailments and disorders, so such diagnoses can severely cripple the remainder of their lives and leave only the option of euthanasia. Bihun’s research is specifically intended for improving and curing animal ailments. Additionally, her research may have potential for human application in the future.

Despite the daunting aspect of researching in a field with little prior knowledge for reference, Bihun studies the isolation of secreted factors from different stem cells, specifically skin cells and, now, neurons. She is currently attempting to proliferate them, which involves a significant amount of trial and error, in order to investigate methods of wound repair and treatment. For her project, she works in vitro with cultured neurons to investigate neuronal repair. After ascertaining how to grow the neurons in cell cultures, she will then damage them to see what kinds of treatments can be applied to fix the problems. Bihun says, "At my level, I am trying to find anything that could work and be applied later. I am looking for some positive improvement in my experiments."

Bihun’s results are encouraging for further studies in this area. Though the isolation of horse neurons is difficult, she has found some potential leads based on literature about humans. When asked about the application of her findings, Bihun says, "We are working out the technical kinks. The results are pretty general so far because there is not a lot to begin with in the first place."

In addition to contributing to a branch of science with several unknowns, Bihun has also come to appreciate the experience of researching at Cornell. She enjoys the contrast between classes, a theoretical and abstract environment, and the laboratory, where she must design practical experiments that require planning and practical application. In the process of writing her thesis, she has learned critical skills, like asking and answering basic science questions.

Despite a heavy workload, Bihun finds time outside of academics and research to participate in extracurricular activities around the Cornell campus. She is a member of the Rise Dance Group and also is a CALS ambassador. After graduation, Bihun plans to pursue to graduate school in a public health field.

This research is being conducted in the Van de Walle Laboratory. To contact the researcher, email ibv2@cornell.edu.
Sailing Towards Greatness
By Mahmudur Rahman

Six hundred years ago, an expedition sponsored by the Ming Dynasty of China dropped anchor in Africa. This expedition was led by the greatest naval commander in Chinese history, Zheng He. With a fleet of over 300 hundred ships, Zheng He sailed to the Persian Gulf, East Africa, and there is some speculation he may have reached the Americas about 100 years before Christopher Columbus. Unfortunately, that seemed to have been the apex of China’s naval history. The subsequent decline of the Chinese naval capacity was highlighted by the country’s inability to defend its ports from European ships during the Opium Wars in the mid-1800s. Those “100 Years of Shame” left a lasting impact on the population of China and it continues to influence Chinese politics today. The effect of Chinese Naval Nationalism has on China’s policies are being researched by a Cornell Undergraduate, Zihao Liu.

Zihao Liu, a senior in the College of Arts and Sciences, born in Kaifeng, China. He is a History and College Scholar double major. As a CAS College Scholar, Zihao designed his own interdisciplinary curriculum to satisfy his personal interests of Chinese government and naval policies. Growing up, he loved to read literature about ships, navy’s, and maritime laws. The interdisciplinary studies in Cornell enabled Zihao to fuse his love of Chinese navy, government, and history. His senior thesis thus reflects the implications of Chinese Naval Nationalism on government policies.

The Great Wall of China is a great indicator of Chinese defense priorities. Throughout history, China was usually attacked through land, especially from the West and North. As a result, the Chinese government allocated its resources to defend its land that were most likely to be invaded. Since China faced no naval threats prior to the Opium wars, a strong navy was never a political priority in China. Even Zheng He’s fleet 600 years ago was to promote trade, rather than to defend the Chinese coastline. During the Opium wars, China was forced to surrender its trading ports to the British vessels and surrendered massive amounts of land to Russia and Japan. Almost immediately, a strong navy became a high priority for the Chinese government. But due to the heavy losses during the opium wars, the Chinese government did not have the financial resources to strengthen the navy. But now China has one of the fastest growing economy in the world, and establishing a strong navy is still on the “To-Do” list. Zihao research suggests that the impact of the 100 years of shame is fueling the rapid development of the Chinese Navy in the status quo.

“Zihao designed his own interdisciplinary curriculum to satisfy his personal interests of Chinese government and naval policies.”

Today, the Chinese government is trying to contrast a Blue Water Navy that is capable of conducting combat operations worldwide by building large surface vessels like aircraft carriers. Zihao’s research is extremely important because such rapid naval development may lead to a naval arms race in the region. Naval proliferation may destabilize the region and increase tensions between China and Japan. Whether the predictions from Zihao’s research comes true, remains to be seen.

Outside of academics, Zihao writes for the Cornell International Affairs Review and The Diplomatist. Additionally, Zihao enjoys watching Game of Thrones and playing basketball with his friends. Upon graduation, Zihao wants to work in a think tank and help shape sound foreign defense policies for China.

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Musical styles have varied greatly over the decades. From rock in the 1950s to hip-hop in the 2000s, the popular songs of each generation exhibit their own distinctiveness and unique flavor while still managing to grab the attention of millions of individuals. People frequently find themselves softly singing these particular songs or playing them over and over again in their heads. So what distinguishes these songs from others? At some point, we have all wondered if certain common elements within music exist that make songs catchier. This represents one of the central focuses of Julia Klein's research.

Julia has been interested in research since high school, where she had participated in a science research program at Loyala University of Chicago, exploring the relationship between anxiety and depression in affluent communities. At Cornell, she got the chance to combine her interest in music and interest for science in the College Scholars major and reached out to Carol Lynne Krumhansl in the Music Cognition Lab in order to further pursue her interests.

In her research, Julia examines the aspects of a song which make it “catchy”, sifting through the songs that have made the Billboard 100 list over the course of the past century to look for common trends in music. In her study, Julia looks at a variety of factors, such as chord progression, singer gender, genre, structure, rhyming patterns, and lyrics to find relationships which can underscore chart performance and predict how a song will do. Looking forward, she plans to analyze the incidence of 1 and 5 cords, tempo, level of complexity during song choruses, and what happens when we encounter songs that are not particularly recognizable to us but possess the same elements as more familiar songs.

Her work so far has demonstrated a strong relationship between the familiarity of reminiscence bump. The reminiscence bump is a term coined by Krumhansl and represents the finding that individuals tend to prefer the music of their adolescence and, very interestingly, the music of their parents’ adolescence. Furthermore, Julia’s data has corroborated these findings. Beyond the research that she does at the Music Cognition Lab, Julia attends various conferences to discuss topics in her field. In the future, Julia expects that her research will assist services, such as Pandora and Spotify, to develop more accurate music preference algorithms. Additionally, she anticipates that various companies will find usage for her studies in developing advertisements. Certain areas in the medical field, such as music therapy for Alzheimer’s might benefit from her work as well.

Having spent three years doing research, Julia feels that she has gained valuable skills from her experience, such as a better grasp of statistics, an ability to organize and synthesize information from raw data, and a good sense for designing experiments. After her time in the Music Cognition Lab, Julia aims to apply the skills she has gained as a researcher in the world of entrepreneurship.

Currently a senior in the College of Arts and Sciences, Julia is part of the College Scholars Program and the Hunter R. Rawlings Presidential Research Scholars Program. Outside of her research, Julia works as an ambassador for the College of Arts and Sciences and as a music director for Nothing But Treble. Furthermore, Julia works with Electric Buffalo Records and enjoys travelling, reading, and playing guitar.
The most renowned gastronome of all time, Anthelme Brillat-Savarin, once wrote, “Dis-moi ce que tu manges, je te dirai ce que tu es”, which translates to “Tell me what you eat, and I will tell you what you are.” Cuisine has been and continues to be a faithful reflection of different societies around the world. Contemporary food initiatives are more prevalent than ever, as people come to view food as not only sustenance, but also a lens through which one can learn about a place and vehicle through which ideas can be transmitted. People’s fascination with molecular gastronomy and dish innovations have become an invaluable subject of study.

Jeanne Kessira, a ’16 College Scholar and history major in the College of Arts and Sciences, studied abroad in Barcelona, Spain this past spring. Having always been interested in global food trends, Kessira remained in Barcelona during summer to conduct research on the relationship between food and society. Barcelona is a unique city to study cuisine because of its juxtaposition between food identity and national identity; although Barcelona is located in Spain, it is an autonomous community of Catalonia and therefore differs from the rest of the nation. Kessira’s research was divided into two parts: fieldwork, in which she attended food initiatives, cooking centers, events, festivals, and university programs, and historical research, for which she frequented the library. Kessira’s main focus involved the study of two streams of food culture: one emphasized local, traditional products of the land. The other stemmed from molecular gastronomy, which transforms foods into meals that people do not recognize in order to pique eaters’ senses and perceptions.

“Kessira concluded from her research that innovative cooking in the Iberian Peninsula bridges tradition and modernity.”

In order to study Barcelona’s food culture, Kessira experienced Catalan cuisine firsthand. She attended cooking centers, where she analyzed the differences between how local Barcelonians and non-Barcelonians are taught how to cook. Moreover, she attended conferences that were organized by the University of Barcelona and frequented food festivals in the streets. One particular dish that she tasted was a variation of botifarra (sausages), which appealed to clients who cannot eat pork. The dish represented society’s move towards taking traditional dishes and making them more accessible to greater portions of the population. Kessira also visited the lab of world-renowned Catalan chef Ferran Adria and studied his creative process of inventing new dishes. His methodology can be applied not only to gastronomy, but also to other fields.

Kessira concluded from her research that innovative cooking in the Iberian Peninsula bridges tradition and modernity. These seemingly different streams of thought are in fact intimately related and intertwine people with the land. She states, “The people-focused food trends in Barcelona reflect the current humanistic revolution in the food world.” What has become as important as cooking is people’s behaviors around food. Food creates conviviality and stimulates thoughts about the role that globalization and industrialization play in food processes.

Kessira’s research experience in Barcelona has inspired her to attend graduate school in Europe, where she will further her studies in food education. Outside her research, Kessira is very involved in the Ithaca community. Kessira participates in the Cornell French Society and Early College Awareness program. In her free time, she enjoys cooking, traveling, and reading.
More than a century ago, the first successful, open-heart surgery was performed by surgeon Daniel Hale Williams. As a significant medical achievement, cardiac operation has since evolved in both approaches and technology with inventions such as the heart-lung machine. Targeting the heart, Evelyn Haynes, a mechanical engineering major from the College of Engineering, is devising and constructing a left atrial surgical access port to assist and facilitate surgical procedures and examinations of this area. Receiving guidance from Professor Ankur Singh regarding the biological academic background and application for her device, Haynes is working on this independent project through the Immunotherapy and Cell Engineering Laboratory and is in the process of developing this surgical access port so it could be employed specially during minimally invasive surgical procedures.

Compared to standard surgeries, during which a single large opening is made, minimally invasive surgeries rely instead on one or several smaller incisions in the skin. Surgeons might, for example during operations on the abdominal cavity, pass an endoscope, a long, thin tube with a miniature camera attached at the end, through one of the incisions so that they can receive a clear, magnified view of the surgical area via images from the endoscope that are projected onto monitors in the operating room. While not all procedures can be performed using minimally invasive methods, such processes are becoming more and more common in hospitals. Though a minimally invasive surgery is longer and more technically difficult than a conventional surgery, patients typically have quicker recovery times and less overall discomfort.

During a minimally invasive operation, the port Haynes is creating would be implanted in the left atrium of the heart at the beginning of an operation, and doctors would then be able to place medical devices, such as catheters and other equipment, into the heart without the consequence of blood loss. With the port, it would be easier to insert and retract devices through this incision without losing as much blood, and in turn speed up procedures and allow surgeons to focus on other aspects of the surgery. Although there are existing instruments and technology available to help with abnormalities and diseases in the mitral heart valve, Haynes believes this a step forward in minimally invasive surgical techniques targeting the heart.

The idea of the access port was inspired and based on Haynes’ work from her summer internship at Cephea Valve Technologies, Inc., a medical device and equipment startup group, with whom she is building the surgical access port. Working together with the company who is providing the technical assistance and funding for the project, Haynes is responsible for every aspect of the apparatus, from its specifications (determining the dimensions and materials of each component) to its design (creating detailed sketches and researching the application of [existing devices] and their functionality in an actual surgical setting). The creativity involved is Haynes’ favorite aspect of this research. Haynes explained, “When I’m trying to solve a problem involved in an aspect of this research, I have to go back and look at existing technologies and approaches, but at the same time keep in mind, ‘What can you do that’s totally new?’” For completed prototypes, Haynes has been testing them by stimulating a cardiac surgery environment using animal hearts from the butcher. Haynes would also send her prototypes to experienced surgeons for professional user-end feedback.

Having only recently started the left atrial surgical access port this fall semester, Haynes anticipates that the development and refinement of the device will cover the duration of her last year at Cornell and hopes to complete the access port as soon as possible. While Haynes would like to have a final product before her graduation in the spring, if it’s still unfinished by then, future plans for the project is uncertain. “At that point it would depend on the priorities of the group I’m working with, though I would love to follow through to completion,” remarked Haynes. Upon leaving Cornell, Haynes is going back to Cephea Valve Technologies, Inc. as a full-time development engineer.
Determined to construct a model of heart disease, Saif Azam researches its mechanisms in order to provide affected mice with the “best healthcare in the world.” While a common approach to treatment is to develop medicines that mitigate symptoms of heart disease in response to known mechanisms, a more precise solution involves modeling the disease from the ground up by investigating the compromised, beating heart at a single-capillary level.

Azam, a senior in the College of Arts and Sciences double majoring in Biological Sciences and Economics, is part of the cardiac imaging team that conducts research at Cornell University’s Schaffer-Nishimura Laboratory, located in the Department of Biomedical Engineering at Weill Hall. The lab uses cutting-edge optical techniques to decipher the mechanisms of disease in an organ at the microscopic level. Unfortunately, little is known about blood flow within the heart itself and observing the beating heart using current microscopy techniques is no easy task. To this end, the lab has pioneered the use of a custom multiphoton microscope to image the capillaries of the beating heart in order to delineate the mechanisms that lead to heart attacks. Specifically, the goal of Azam’s research is to understand how these mechanisms are reflected in changes in blood flow.

“In lab, Azam performs surgeries on his mice by attaching a window to the beating heart and using two modalities to isolate blood flow through the vessels.”

In lab, Azam performs surgeries on his mice by attaching a window to the beating heart and using two modalities to isolate blood flow through the vessels. The first involves using multiphoton microscopy to penetrate the deep veins of the heart at the resolution of a single cell while the second uses laser speckle contrast imaging, in which red blood cells scatter light, blurring an otherwise coherent field of speckles, to image superficial (surface) vessels. Since the heart is a beating organ, Azam times the capture of his images to the diastolic phase of the heart, when it is not contracting. These methods enhance pre-existing surgical approaches to investigating blood flow in the heart by being less invasive, meeting physiological conditions, and keeping the mouse alive.

The goal of this project is to understand the mechanisms underlying tissue lesions that lead to heart attacks and how the heart responds to reroute blood flow. Heart attacks occur when narrowing vessels prevent adequate supplies of oxygenated blood from reaching parts of the heart, leading to heart muscle damage. If blood flow does not improve, heart cells die and scar tissue forms, eventually leading to death. Current data indicates an increase in relative blood flow in superficial veins following heart tissue lesions. Azam aims to examine the validity of this data using his two-microscope system to obtain higher quality data with more controls. In addition, he aims to investigate changes in tissue lesion boundaries by conducting histological studies in which he sections a mouse’s heart to microscopic thinness and dyes its oxygen-deprived tissue. The ultimate purpose of these experiments is to use and improve these fine-tuned models to understand how different drugs could alleviate symptoms to the point of saving lives.

A significant lesson Azam has learned through the years is that research is “an iterative process.” He stresses that “Much energy is needed to make small steps to learn and improve.” For Azam, learning occurs mostly in the troubleshooting stages of experiments, where a thorough understanding of experimental scope and procedure leads to an understanding of faults. He finds the gradual but steady progress on his model rewarding and remarks, “I find peace doing experiments. Working in the lab and doing surgery on a mouse can be quite meditative.”

Beyond working intimately with mice to deliver them the “best healthcare in the world,” Azam is involved in several student organizations on campus. He is member of Badmaash, a fusion dance team, the student assembly, the Phi Delta Epsilon fraternity, and MECA, the Muslim Educational and Cultural Association. His hobbies include playing tennis, basketball, and making full use of Ithaca’s renowned parks and gorges. After graduating from Cornell, Azam hopes to attend medical school.

Adam Zaghouani ’18 is in the College of Arts and Sciences. He can be reached at aaz27@cornell.edu.
If you were researching the origins of the universe, how do you think you would figure out what happened in the moments immediately following the Big Bang? According to Sarah Marie Bruno, a senior in the College of Arts and Sciences, one of the best ways is to take precise measurements of the cosmic microwave background (CMB)’s temperature and polarization. In the very early universe, radiation that would become today’s uniform CMB became polarized due to collisions with free electrons. If our current model of the Big Bang is correct, the universe’s rapid inflation would have produced gravitational waves—ripples in space-time—that had a measurable effect on this polarization. As a result, CMB polarization measurements could provide strong evidence for inflation and the existence of gravitational waves, as well as aiding our understanding of dark energy, the composition of the early universe, and the universe’s curvature. Bruno works on improving the technology that makes these measurements, so that we can make even better observations of the CMB.

Although Bruno, who is majoring in physics, has always had an interest in astronomy, she wasn’t initially involved in cosmological research. At Cornell, she started off in the field of biophysics, studying the communications networks of the social amoeba Dictyostelium discoideum. Bruno enjoyed her research on the amoeba, but she decided to explore another side of physics in the summer after her sophomore year by joining Professor Michael Niemack’s lab.

Niemack’s lab works in collaboration with the Atacama Cosmic Telescope Polarimeter (ACTPol)—a telescope built specifically to make detailed measurements of the CMB—to study topics in cosmology. Bruno’s current project is using Python to model the telescope’s optics. She found that the refractive optics used in the telescope rotate the polarization of incoming light, affecting the accuracy of CMB measurements. She hopes to model this so accurately that she can predict the amount of rotation and correct the telescope’s readings.

“We’re on the verge of getting to the level of precision that we need to make a lot of scientific advancements. It’s incredibly exciting,” Bruno said. With precise enough measurements, scientists will be able to determine whether fluctuations in CMB polarization reveal the signature of gravity waves.

Bruno is also designing a physical model of the system she studies, which she plans to begin using next semester. The model will be a smaller-scale version of the optics in the ACTPol telescope that she can test to confirm her simulated results. The tests will involve shining a laser into the model’s light detector and measuring how various lenses rotate the light’s polarization. To accurately emulate ACTPol, the detector will need to be cooled down to one degree Kelvin! Bruno hopes what she learns from physically modeling the telescope’s optics will aid scientists who are designing Advanced ACTPol, a new and upgraded Atacama telescope.

Outside of the lab, Bruno is a member of the Cornell Chorus, a student assistant at Hans Bethe House, and the president of the Society of Physics Students. Last summer, she explored the overlap between cosmology and particle physics at the Large Hadron Collider, where she simulated technology used to measure the energies and properties of elementary particles. She also has a strong interest in the intersection of science and writing. As a sophomore, she created a series of brochures for middle school students explaining topics in physics, which were distributed at Cornell’s synchrotron, New York State Space Grant schools, and the Syracuse Museum of Science and Technology.

Bruno hopes to continue working with the CMB and astronomical instruments after she graduates, and would like to someday contribute to designing telescopes for spacecraft, balloon-borne experiments, and ground-based observatories. “I’d really be interested in any of those projects, as long as I can keep looking at the CMB,” she said.

This research is being conducted in the Niemack Laboratory. To contact the researcher, email smb377@cornell.edu. and correct the telescope's readings.

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Stephanie Yan ‘18 is in the College of Arts and Sciences. She can be reached at smy43@cornell.edu.
While "protein" may sound like the buzzwords of fitness gurus, these molecules actually serve a plethora of important functions in human cells. They can be reaction catalysts, chemical receptors, and support structures in cells. Understanding proteins and the mechanics behind how they work could help scientists in a plethora of fields, from medicine to environmental science to fashion.

Maria Sirenko is a senior graduating in the fall of 2015 from the College of Engineering who works with Professor Warren Zipfel in the Zipfel Lab in the Department of Biomedical Engineering. She is researching a new imaging technique that can determine a protein’s stoichiometry. Protein stoichiometry, one of the many fields in proteomics, is the study of the composition of subunits of a protein and how the subunits interact with one another. Knowing the stoichiometry of a protein allows scientists to understand the mechanics behind its function. While other techniques exist to determine the stoichiometry of a protein, these methods tend to use detergents, which can potentially disrupt protein interactions. Thus, there is a need to develop a technique to develop new high resolution imaging that preserves in vivo protein stoichiometry.

The process begins with the tagging of the target protein (in Sirenko’s experiments, EGFR and ADRβ2, both well studied receptor proteins) with a fluorophore, a light-emitting chemical compound that functions as a tracer. Then, the cells that are producing the tagged protein are plated with a surplus of cells not producing the labeled protein. These surrounding cells express the vesicular stomatitis virus glycoprotein, used by viruses to fuse to the cell membrane. When expressed in mammalian cells, this protein causes the cell membranes to fuse together, forming a large multinuclear body. In the multicellular matrix that forms, the proteins spread out by diffusion, reducing the effective concentration and allowing them to be identified and studied individually. The proteins are then imaged using lasers to excite the fluorophores. The emission fluorescence decays in a step-like manner, with each step corresponding to one subunit present in the complex. By comparing the number of subunits calculated using her technique to the number of subunits the proteins were already hypothesized to have in the literature, Sirenko verified the stoichiometry determination technique.

Even though the technique was only recently developed, it is already starting to make a strong impact. A collaborator at the University of Rochester is interested in using this technique to determine the stoichiometry of metabotropic glutamate receptors, a type of membrane protein often found in the synapses of neurotransmitters. This method can be applied to a wide variety of proteins and has the potential to greatly contribute to the field of proteomics.

This is far from the only experience Sirenko has had with research. In high school, she worked on a research project on Alzheimer’s disease as well as another on biofuels. Here at Cornell, she is a Rawlings Research Scholar and co-president of the Cornell Undergraduate Research Board, which helps undergraduates find mentors and labs in which they can conduct research. Research is also in her future. She is currently in the midst of applying to graduate school, with a long-term goal of becoming a professor and heading her own lab. When asked what drew her to research, she said, “Research lets you get hands on with science. You contribute to the knowledge pool and develop the technologies of the future.”