Fall 2016

Features

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“Our vision as the founders of The Research Paper is to create a magazine that humanizes research on all levels. We believe that research is as much about self discovery as it is about achievement. In addition to showcasing the outstanding research that is conducted here at Cornell, we also aim to highlight the uniqueness, creativity, and personality of each researcher to all of our readers. We do this by focusing our articles on who the researcher is, what they are involved in both at Cornell and in their local communities, and what their future visions and aspirations are.”
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For this issue, the cover of The Research Paper came from a photograph taken by Olivia So, a senior Urban and Regional Studies major in the College of Architecture, Art and Planning. She took this photo of McGraw tower on Cornell’s Ithaca campus.

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From Disney movies to Animal Farm, talking animals are common subjects of fiction. But are they confined to fiction, or do animals actually “talk” in real life? Severine Hex’s research seeks to answer that question.

A junior in the College of Arts and Sciences, Hex created her own major through the College Scholars Program, entitling it “Investigating Nonhuman Language.” Her independent research focuses on reevaluating current definitions of language and exploring how they could apply to other species. Currently, she is reviewing the literature on animal communication and the identifying the traits of species that exhibit complex communication. She hypothesizes that language evolves in species with social structures that require cooperation. For example, language may be found in monogamous bird species where the two parents have to coordinate to care for their offspring, and in species with stable social hierarchies and cooperative breeding and hunting, like lions. Using the traits that she has identified, Hex hopes to be able to predict among which species may have evolved a linguistic system and directly research those species.

Hex’s research on nonhuman language began in her own laundry room, where she kept her pet zebra finches. As a high school student in Idaho, she studied their changes in vocalization patterns. This project formed the basis of her high school senior thesis. At Cornell, she continues to work with zebra finches in the Behavioral Analysis of Beginning Years (B.A.B.Y.) Lab, which explores the parallels between how toddlers and young male birds learn to speak and sing, respectively. The lab has found similarities in how children and birds acquire language: for instance, both rely on feedback. For children, this feedback is from parents, and for male birds, it’s from females wing movements. Michael Goldstein, the principle investigator of the B.A.B.Y. Lab, heard about Hex’s interests from a postgraduate student and invited her to apply. Hex is grateful to him for helping direct her inquiries and for encouraging and challenging her to perform rigorous research.

Hex’s plans for the future include an innovative mixture of zoology and research. She wants to run a zoo that doubles as a laboratory, where zookeeper-researchers study the animals in environments as naturalistic as possible and welcome the public. Hex sees zoos as an opportunity for conservation education and to improve communication between the scientific community and the public. Rather than read about research in second-hand pop/pseudoscientific articles, zoo patrons could interact directly with the researcher-zookeepers, leaving a more meaningful impact. Unlike too many zoos, Hex’s would “put the animals before profit.”

Yet Hex’s investigation of nonhuman language extends beyond science. At age 12, Hex began to write a the Fate Trilogy, a set of novels that explore social dynamics and human nature. However, her characters are swift foxes. The pack forms and breaks alliances and new leaders emerge, highlighting the parallels between human politics and animal behavior in social groups. Now, Hex looks forward to publishing a combined edition.

As a scholar, author, and researcher, Hex delves wholeheartedly into her investigation of nonhuman language. Potentially, her research could forever change the way we view other species. So next time you hear a crow caw, take a moment to listen and ask yourself: is it really that different from a foreign language?

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Despite the vast knowledge modern medicine has provided, much about pregnancy and birth is still unknown. The health of the mother can greatly affect the well-being of the fetus and vice versa, but scientists are looking to expand on this general statement. Cornell University is working to support these advancements in the sciences through people like senior Gabrielle Steinl, who currently researches aspects of the fetal-maternal relationship and their association to birth outcomes.

Steinl is majoring in Human Biology, Health, and Society in the College of Human Ecology. Before coming to Cornell, she had a summer of part-time research experience in an oncology lab with a major focus on stem cell cancer studies. She was introduced to the basics of working in a lab and especially the idea of researchers having separate roles but uniting under the theme of the lab’s focus. She also learned valuable skills such as culturing cells. When she arrived at Cornell, Steinl was eager to become involved with research during her freshman year as she felt research was critical to understanding the health sciences. To do so, she emailed labs based on her personal interests in nutrition and found Dr. Kimberly O’Brien’s lab in the College of Human Ecology. After a successful interview, she began performing basic lab tasks and preparatory work for upper-level students, before gradually working her way to having independent research projects.

This research is conducted in the College of Human Ecology in the Department of Nutritional Sciences under the supervision of Dr. Kimberly O’Brien. To contact the researcher e-mail gks43@cornell.edu.

Much about placental interactions and regulation is still unknown, and the O’Brien lab focuses on some of these aspects, specifically on maternal and fetal nutrition and largely how nutrition status in the mother affects both the fetus and the mother. Steinl’s first project concerned the relationship between the degree of umbilical cord coiling (hypocoiled, normal, or hypercoiled) and iron status in the mother and fetus, along with various birth outcomes like preterm delivery and low birth weight. The O’Brien lab’s previous studies showed that many negative birth outcomes are likely in high-risk pregnancies, usually in teenagers and mothers carrying multiple babies. Adding to this research, Steinl found that lower iron status is associated with hypercoiling of the umbilical cord, while earlier gestational age of the delivery were associated with hypocooling. She is currently in the process of publishing her results.

Regarding the applications of her findings, Steinl said, “We don’t really know the cause of coiling. Other studies have associated negative things with abnormal cord coiling, like lower weighing status. My identifications add to the literature and emphasize why it is important to study umbilical cord coiling and to know what the abnormalities will cause.” Steinl’s senior project is part of the Hunter R. Rawlings III Presidential Research Scholars program. She is studying the physical activity levels in pregnant teenagers and associations with birth outcomes such as gestational weight.

Steinl highly values the lessons and skills she has learned over the course of her four years as a researcher. “Doing research yourself and starting early helps you understand where recommendations and guidelines in the healthcare world come from. I question all of the scientific literature I read, and less scientific news articles become more apparent,” she said. “Knowing about confounding variables and small sample sizes as a detriment makes you question what you read instead of relying on other people’s summaries. You decide for yourself what is really important.”

In addition to her academics and research, Steinl is heavily involved as a coxswain on the Cornell Men’s Varsity Lightweight Rowing team. She independently volunteers at a senior living community called Kendal At Ithaca Assisted Living. She also likes to read the New York Times in her spare time and listen to interesting podcasts.

After graduation this spring, Steinl will be attending medical school. Though she is still undecided about the particular field of medicine, she hopes to explore her many interests in nutrition, sports medicine, orthopedics, and newly developing areas like obesity medicine. After her research experience at Cornell, Steinl plans to definitely pursue research in her medical career. She wants to try a few different fields and even attempt clinical research as a new experience before finalizing her choice.

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Technological innovations have affected the entirety of our existence in multiple dimensions, including healthcare. Contributing to the wealth of knowledge on how technology can help people is Rohit Biswas, a Computer Science major in the College of Engineering. A Rawlings Scholar and member of the Class of 2017, Biswas is from Somerset County in New Jersey. Biswas is conducting research in the field of Computer Science to help people with chronic back pain, though his passion for applying research to real-world issues began when he had the opportunity to conduct research on how cancer spreads through the body. This was when Biswas was a Biomedical Engineering major. After becoming interested in Computer Science, he decided to do research in the field since “it was a new experience.” But he still “wanted to maintain a human connection.” Biswas had a solution to his conundrum: “I combined Computer Science and helping people with physical health and mental health issues.”

Biswas joined the People-Aware Computing Lab in Gates Hall, where he conducts most of his research. The research project he undertook involves creating a phone application that tracks movement. In particular, it tracks “different features of a person’s health, like where you are, how much exercise you do, and whether you’re running or walking.” The application also sends users notifications reminding them to exercise. Biswas coded the application and assisted in interpreting the statistical models that underlie the application. The application was calibrated in accordance with doctors’ recommendations, and was subsequently provided to participants with chronic back pain in a controlled study at Weill Cornell Medical School.

The results of this study have not been published, as they are still being analyzed. However, one participant in the study was excited by the application and wanted to keep it. Biswas thinks people might appreciate having “an external force telling them continuously to keep exercising.” The research will be used to try to “show trends between a person’s behavior and technology that communicates with people. There’s a lot of Artificial Intelligence behind this research. The app is supposed to learn, and it should be able to adapt to people’s preferences.” In particular, the app should be able to detect what kinds of exercises users prefer and the optimal frequency for reminding users to exercise. Biswas hopes that his research will help people exercise to improve their health status: “It’s hard to be active with chronic back pain, but activities like walking and running are the main ways to heal back pain. I’m really happy that my research can actually help people with their pain. It has a human element to it, unlike other kinds of research. I’m helping to solve real world problems.”

“I combined Computer Science and helping people with physical health and mental health issues.”

Biswas’ current research has to do with mental health on college campuses. He is studying location data as it corresponds to mental health, trying to find a relationship between the state of someone’s mental health and their location. From his previous experiences with research, he has learned that “there’s a correlation between how much time you invest into something and how much you gain from it.”

Currently, Biswas is trying to find a job in the Computer Science industry, preferably in work related to software engineering. Alternatively, he may attend graduate school and earn an M.S. in Computer Science, specializing in Machine Learning. While at Cornell, he attended a Hackathon in Princeton, wherein his group attempted to find a correlation between Twitter and emotions in a given area. He enjoys cooking, volleyball, and video games, and is a superhero aficionado.

Rohit Biswas is grateful to Hane Aung, Mashfiqui Rabbi, Saeed Abdullah, and Tanzeem Choudhury for their support in the coordination and management of his project.

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Vianna Chan spent this semester hauling several pounds of apple pulp from the Cornell Orchards to her laboratory in the Human Ecology Building. A senior studying Fiber Science, Chan has recently perfected a technique she uses to process fruit pulp into superfine microfibrillated cellulose, which she hopes to use to design eco-friendly water filters.

Most students who hear “fiber science” associate it with fashion design, but Chan works outside of the conventional field using cellulose fibers for non-apparel applications. She explains that current water filtration systems like reverse osmosis are financially and energetically costly to build, and often produce toxic byproducts. She hopes to reduce their environmental impact by showing that water filters can be made from organic materials. “It would be counterproductive, and very ironic, to design a filtration system that leeches the very contaminants it seeks to eliminate in water,” says Chan.

Most of Chan’s work has centered around creating superfine cellulose from two biological sources: fruit pulp and bacteria. By combining the fibers broken down from fruit and those synthesized naturally by Acetobacter xylinum, she hopes to engineer a stronger material. Along the way, she has made several modifications to the process used industrially. Some of these changes are designed to make the procedure more eco-friendly, but others were born from necessity, as her lab lacks the equipment designed for large-scale production.

“I’ve cut out the step that most people use, which is applying very strong sulfuric acid to strip away the excess parts of the your fruit pulp in order to get the fibers,” says Chan. Instead, she avoids introducing harsh chemicals into the process by using an autoclave, a pressure-controlled container where she can drop the pressure rapidly to force the fibers to separate. To make the fibers fine enough for a filter, she then repeats the high-pressure treatment two times and processes the pulp with a grinder.

Chan says that designing this specific modification has been her greatest hurdle so far. To fine-tune her procedure, she had guidance from Dr. Anil Netravali in the Department of Fiber Science. During their weekly meetings, he would listen to her plans and point her in the right direction. Chan, who began her project thinking that she would be done before her senior year, says she learned the hard way how much patience is required for successful research.

“When you’re a novice to something you think everything is possible, and the more you know about something the more you realize certain ideas aren’t feasible,” says Chan. “There’s just a lot of variables you need to take into account, and sometimes you don’t realize if you’re overlooking something.”

Chan is currently focusing on the second half of her project, combining the cellulose she extracted from fruit pulp with cellulose synthesized by A. xylinum. She hopes that by allowing the bacteria to weave the two fibers together, she can encourage faster production in addition to making a stronger composite. “Before I graduate, I’d like to be able to test the filter and show that it filters water correctly and also kills bacteria,” says Chan.

Chan found her passion in materials research early in her Cornell career, but like many students, she originally came to Cornell as a pre-medical student. She chose fiber science because it fulfilled many of her pre-med requirements, but she knew that she “wanted to do something along the lines of chemistry... that was little more application focused.” Now, she plans to work in textiles engineering or materials consulting after she graduates, where she’ll be able to put the skills she gained from making eco-friendly filters to use.

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The United States is unprepared for the overwhelming influx of individuals who will need to enter senior living, an issue that the middle class currently faces. Carly Andrews, a senior graduating in December and a Rawlings Presidential Scholar, hopes to use her research to address the lack of supply in the middle-income market of the senior living industry. Andrews comes from Long Island and is in the School of Hotel Administration, holding a minor in Gerontology. Prior to developing her research in the field of Gerontology, Andrews focused on the Food and Beverage Industry, partly influenced by her previous work as a wedding cake decorator. While conducting research on restaurant technology, she interned at Brookdale Senior Living in the Food and Beverage sector, where her passion for bettering the quality of life for the elderly grew: “I fell in love with working with senior adults and realized how much opportunity there was for young adults to make an impact in their lives. It’s business with a heart.

In her initial research on the senior living industry, Andrews learned that the middle class has limited options, because most companies are either luxury and high-income, or smaller and low-income. In addition, “Baby boomers haven’t saved enough money for retirement and a lot don’t think they will need long term care, but they will. They are unprepared to pay for the options available, which means they will go into Medicaid facilities and overwhelm the system. So, a framework is needed to provide them with the best care for them, or else they will be underserved.” By identifying upper, middle and low-scale options in the hotel industry, she hopes to create a value-based model for senior living, such that good care at a lower price can be available to senior adults in the near future. In the hotel industry, prices are matched to a realistic expectation. In the senior living industry, this isn’t the case, causing a lot of misconceptions. Quality of care is a standard expectation across senior living communities, so the main selling point for a developer would be amenities. Andrews is trying to develop not only a framework that will create a middle ground between expectation and cost, but also one that is scalable. However, scaling these operations poses issues: “Current middle-income models are disjointed and unable to serve the demand. A scalable model is largely dependent on effective labor management and good care providers.”

Andrews’ research has primarily been conducted through literature reviews on existing research in Hospitality and Gerontology, interviews, and cross-industry innovations—in particular, applying hotel industry development to the senior living industry. She finds passion in her research and takes pride in knowing that it could change people’s lives for the better by targeting an issue before it worsens: “I really like solving problems, and this project is solving a problem I really care about—providing great care for the elderly and making sure they are cared for and valued instead of thrown into institutions just because it will be cheaper. This is a problem people aren’t thinking about but will need to. I’m using my research to help people live better lives.” Andrews conducts her research with the support of the Cornell Institute for Healthy Futures (CIHF), and is grateful for the support of Rohit Verma, her research advisor.

In the past, Andrews has attended the Hospitality, Healthcare, and Design Symposium, where she and her former supervisor presented on implementing hospitality into senior living without affecting the autonomy of residents. Carly Andrews is Co-President of Cornell’s Healthy Futures Student Organization and a member of Alpha Epsilon Phi Sorority, The Outdoor Club and The Cornell Elderly Partnership. She enjoys hiking, baking, and being a fan of Harry Potter. She plans to gain operations experience and determine the challenges that she would need to meet in order to effectively implement her model. In the future, she looks forward to earning an MBA and running her own business.
Diphtheria, a bacterial infection resulting in inflammation of the throat, saw many epidemics in the 20th century. One particular outbreak and the subsequent race to deliver diphtheria antitoxin in Nome, Alaska inspired the Iditarod Trail Sled Dog Race, while an explosion of diphtheria cases in the 1990s resulted from the dissolution of the Soviet Union. With the advent of vaccines, the disease is now rarely found in America, though it continues to cause illness globally. While diphtheria is transmitted similarly to most diseases, its method of action is unique, for the disease-causing bacteria releases a toxin that binds to a molecular modification like no other – diphthamide.

Alisa Lee, a senior with a major in Chemistry and Chemical Biology in the College of Arts and Sciences and a minor in Nutrition and Health in the College of Human Ecology, researches diphthamide biosynthesis in Dr. Hening Lin’s lab. Diphthamide is a post-translational modification (PTM), a modification of a protein following translation of mRNA. Most PTMs, such as methylation or phosphorylation, affect many proteins. Diphthamide, however, is only found on a protein called eukaryotic elongation factor 2 (eEF2), which is essential for translocation of the ribosome during translation. Diphthamide is targeted by diphtheria toxin, which is produced by a pathogenic bacteria. “Scientists are interested because diphthamide is found in all eukaryotic organisms, ranging from yeast to humans,” says Lee. “It would not be evolutionarily conserved if its only role was to make us susceptible to the disease.”

One way to begin understanding diphthamide’s role is to learn about the pathways that produce it. In 2014, a graduate student in the Lin lab under whom Lee was working discovered a previously overlooked step in diphthamide biosynthesis. This step is carried out by an enzyme called diphthamide biosynthesis 7 (Dph7), likely using a novel mechanism. Lee’s current goal is to identify catalytic residues of Dph7, the specific amino acids of Dph7 that help produce the diphthamide modifications. She does this by using molecular cloning techniques to generate mutations in Dph7, a process known as mutagenesis. She then effectively screens for mutations that abolish Dph7’s catalytic activity. For example, Lee takes a yeast strain with the original Dph7 copy deleted, then reintroduces a mutated version of Dph7. She then expresses diphtheria toxin in these cells. If the cells die, the inserted Dph7 gene was still functional and thus produced a diphthamide modification that could be targeted by the toxin. If the cells survive, she has successfully mutated a part of the enzyme essential for diphthamide biosynthesis, and will have found a potential candidate for a catalytic residue of Dph7.

Using this screen, her research group has identified one important catalytic residue so far. Lee is also looking for cases in which double mutations are needed to disrupt Dph7 function. However, she keeps the big picture in mind, noting that the eventual goal is to “find the function of diphthamide, how it is formed in the cell, and what regulates it.” Interestingly, people with tumors often have the diphthamide biosynthesis genes deleted. The understanding of diphthamide biosynthesis will help to illuminate why deletion of diphthamide biosynthesis genes promotes tumorigenesis.

Through research, Lee has learned everything from dexterous technical skills to evidence-based scientific thinking. She has been able to experience the “joy of discovering the unknown,” says Lee. “A lot of research is trial and error, because most things that you try do not work. It takes many trials and perseverance not to give up.” Her perseverance and hard work have been rewarded – she recently got contributing authorship on a Nature Chemical Biology manuscript for her sophomore year research.

The next step for Lee is dental school, where she plans to get involved in oral health research, with a focus on biomaterials and tissue regeneration. Lee urges students to “explore your options when you are looking into research,” noting that she first learned of the Lin lab through her general chemistry TA who happened to be part of the research group. And equally importantly, “when you are doing research, perseverance is the key.”

When Lee is not in the lab, she can be found playing the piccolo in the Big Red Marching Band or making arts and crafts. She is also the president of Global Medical Dental Brigades, treasurer of Encouraging Young Engineers and Scientists (EYES), and managing editor of The Research Paper. Jane Wei ’18 is in the College of Arts and Sciences. She can be reached at jmw487@cornell.edu.
They spend their lives as gods among men, often revered as idols and role models. They are bigger, faster, and stronger than the average person, sculpted and trained to perform. They unite people of all backgrounds, generate massive revenue for multiple industries, and incite passion within and between countries. And yet, in the wake of their glory days, they often are overcome by one of the highest rates of depression, bankruptcy and lack of education than seen in almost any other demographic. This is the story of many modern day professional athletes.

Considering the extensive impact that the professional athletes have on the life of an average person, it is surprising that so little is being done to help them redirect their talents in new directions after their sports career. This is the gap that sophomore Margot Werner aims to bridge with her research, which studies what can be done to help transition professional athletes from life in the stadium to everyday life. A Rawlings Scholar in the School of Industrial Labor Relations, Werner is motivated by her passion for sports. She uses her grant to learn more about what constitutes a high quality of life and a successful retirement, and what we can do as family, friends, and leagues to ensure that athletes are as successful post-sports as they were on the ice, the field, or in the pool.

Werner has designed a branded sports quality of life survey including questions about mental health, educational background, financial status and assistive planning programs. The responses will then be combined with personal interviews that Werner will be conducting with former athletes and league management, as she tries to further gauge exactly what programs exist today and what programs are still needed. The goal of this research is to quantify data using a powerful statistics package called Minitab to analyze the survey data on multiple parameters. From there, she seeks to develop recommendations for what can be done both before and after the career of an athlete to help them smoothly transition to everyday life.

Though this study is still in its early stages, Werner has proposed a few hypotheses about what she expects to find from this research. She stated that “given the right education, emotional support and awareness of the future, athletes should be able to transition smoothly.” Werner also pointed out that not all professional athletes have a college degree requirement, or that they might attend for a year or two, but often with their athletics trumping academics. Werner proposes that “With a more concrete system or requirement in place, athletes could gain educational skills that greatly help them redirect their talents to a new profession post-sports.”

In addition to an education requirement, Werner proposes that counseling for retired athletes. Werner suggests that the leagues play a bigger role in assistive planning programs, particularly financially, and emotionally if needed. Many professional athletes come from financially disadvantaged background and they can be overwhelmed while living in the “fame and fortune bubble” that comes with a professional career. As a result, some have a tendency to quickly lose their newfound wealth. To avoid this, Werner believes all players can benefit from learning to manage their money and need to be educated about investment strategies.

Athletics is close to the heart of not just the American people, but also everyone in the world. Professional athletes have the potential to greatly influence youth, and therefore it is crucial that these athletes can live healthy and happy lives even once their careers are over. As put by Werner, “the influence of these athletes is vast, often when they’re successful, we feel successful; when they fail, we feel as if we have too.”

Werner aims to develop specific recommendations that will positively change players’ post-sport trajectories, with the end goal of these ideas getting adopted by the industry. She also hopes that her research will help her make connections within the industry; she aims to one day become the first female president of an NHL team. For now, she remains content working towards creating new guidelines to help protect players both now and in the future.

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