Highlights of Undergraduate Research at The Ohio State University

Summaries of selected research projects presented at the 2008 Denman Undergraduate Research Forum
CONTENTS: Research Summaries

Why You Would Rather Be an Opossum Than a T. rex
Matthew Borths, ’08; Geological Sciences

A Better Way of Measuring Stress in Cancer Patients
Brittany Conner, ’09; Psychology

Shining a Light on DNA Breakdown
Marc Coons, ’09; Chemistry

New Approach to Treating Brain Cancer
Ravi Gupta, ’10; Molecular Genetics

Women in White Coats
Jessica Hanzlik, ’08; French, Physics

A Project... in Black and White
Jennifer Harris, ’08; Psychology

Preserving Identity
Erica Haugtvedt, ’09; English

Staying Clean in the Greenhouse
Amanda Hayes, ’08; Plant Health Management

Religious Freedom or Equality?
Mitch Hendy, ’08; Political Science

Injury around the World
Michael Jaung, ’08; Microbiology, International Studies

Cold-Water Hurricanes: How Cold Can They Go?
Rachel Mauk, ’08; Physics, Geography

Pomegranates for Your Health
Kathleen Nemer, ’09; Human Nutrition

Dissecting Language
John Pate, ’09; Linguistics

What’s a Saturday in the ‘Shoe Really Worth?
Kevin Roshak, ’09; Economics, Finance

An Up-Close Look at a Muscle Blocker
Tara Satterfield, ’09; Molecular Genetics

The Pod Project—Sustainable Living
Kara Shell, Douglas Powell, Anna Schwinn, ’08; Mechanical Engineering
Gregory Delaney, Elizabeth Evanoo, Gregory Tran, ’08; Architecture

Variations on a Gene
Andrew Spearman, ’08; Biology

Air Pollution: Ohio’s New Plague
Matt Verdin, ’11; Philosophy
Zubin Yavar, ’11; Biology

Midwest vs. East Coast
Jennie Ziegler, ’08; English
Each year, students are invited to present completed projects or works in progress at the Denman Undergraduate Research Forum. Some of these projects are quite technical because they are carried out in specialized fields of study. To make them more accessible to a general audience, we collected the following non-technical summaries from representative students.

Many Ohio State University students are involved in research and other creative activities outside of normal coursework. Working with faculty, graduate students, peers, or independently, these talented and highly motivated students are an inspiration to the entire university community. We invite you to browse these pages to see the excitement, value, and diversity of their accomplishments. This is a brief introduction to the types of research projects our students are working on.

A list of all student projects with complete abstracts from this event is available at the Denman Forum web site, denman.osu.edu. You can also find undergraduate honors theses at Ohio State’s Knowledge Bank, kb.osu.edu. In 2008, 415 students participated in 374 projects.

We thank Richard and Marte Denman and the Honors & Scholars Center at Ohio State for supporting the forum; corporate forum sponsors Procter & Gamble, Eli Lilly and Company, Abbott Nutrition, Battelle Memorial Institute, and the redoutfoundation; Dr. Gerard and Mrs. Rossala Boutin; and the many students, faculty, and staff who contribute to undergraduate research activities at the university. We are grateful to Joe Inglis, a visual and communication design major, for the wonderful illustrations in this booklet; to recent Ohio State graduate Lindsey Perry, who created the image of the lantern on the back cover; and to graduate associate Holly Wagner, who worked extensively with the students featured here.

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Sixty-five million years ago, dinosaurs were driven to extinction along with many plants and animals, including many species of mammals. The creatures were probably wiped out by an asteroid that struck the Gulf of Mexico and launched incredible amounts of debris into the atmosphere. This debris caused a thermal pulse of radiation that made the surface of the planet feel like an oven on broil for several hours. A couple of years ago, a group of scientists suggested that terrestrial animals surviving this mass extinction found shelter from the radiation by going underground or underwater. I studied the mammalian fossil record to look for any evidence of burrowing or swimming animals during the end of the “Age of Dinosaurs,” and to see if these animals survived into the “Age of Mammals.” Using fossilized arm bones from mammals before and after the extinction of the dinosaurs, I found evidence of great diversity in mammalian locomotion while the dinosaurs were stomping around. Although many mammals could burrow or swim, having either talent didn’t necessarily help an animal stay alive. The animals that survived to repopulate the new ecosystem were small. They were generalists capable of exploiting all kinds of niches and resources, proving that it pays to be adaptable.
Cancer patients endure unique hardships related to the stress of their illness. When we started our work in 2007, we found that depression and anxiety related to the disease had no effect on a patient’s stress level. But we weren’t using the right tool to measure stress—we were simply asking patients, “What is most stressful to you now?” So we changed our approach and used the National Comprehensive Cancer Network’s (NCCN) “Distress Tool.” We tweaked this measurement tool somewhat and tested it on patients at the Pain and Palliative Medicine Clinic at the Arthur G. James Cancer Hospital and Richard J. Solove Research Institute. The NCCN Distress Tool assesses 57 problem areas, including practical, emotional, social, physical, and spiritual concerns. Patients can also rate how much distress they are experiencing overall. Because this tool is so successful, we are currently preparing a proposal to use it more broadly at the James and the Lance Armstrong Survivorship Center. Having this information can help health care providers pinpoint their patients’ top concerns.

DNA undergoes photochemical reactions when it is exposed to ultraviolet (UV) radiation. These reactions ultimately cause mutations that can lead to cancer and cell death. I study the major photochemical products formed when DNA is exposed to UV radiation. I look specifically at the geometric criteria that are needed for these mutations to happen. For the mutations to occur, DNA bases must be aligned a certain way. I basically trap DNA molecules in glass. Doing so hinders their movement. I then bombard the glass with UV radiation and monitor the effects on the molecules. The results give me information on how DNA degrades in an environment that mimics a cell. The goal of my work is to further study the kinetics of DNA photodegradation. Already, the results have created more questions than answers.
I study a class of recently discovered molecules called microRNA (miRNA). These molecules are a double-edged sword—in some cases, they cause cancer cells to grow. Yet in other cases, miRNA molecules can inhibit the formation and growth of tumor cells. I focus on the role of miRNA in glioblastoma multiforme, one of the most common and aggressive forms of brain cancer. Few patients with this disease survive beyond a year after diagnosis, even with treatment. So it is essential to find ways to treat this disease that can prolong a patient’s survival. I studied miRNA-1, which suppresses a gene that makes cancer cells grow. In laboratory experiments, tumor cells with low levels of miRNA-1 grew rapidly because they readily expressed this gene. Confirming that miRNA-1 exists in very low levels in brain tumors may allow researchers to develop new ways to treat brain cancer.

France has a closer-to-parity distribution of gender within the sciences than the United States. I looked for cultural and historical differences between the two countries in an effort to understand why. I read about the historical traditions of both countries, with an emphasis on the development of feminism and the rise of women in science. I traveled to France, where I interviewed female scientists to learn their thoughts on this issue. I ultimately found that there are several major differences between France and the United States. For instance, France is a more socialist country with a system of support in place that provides maternity and paternity leave, child care, and paid vacations. Also, the female scientists I interviewed emphasized that the French don’t think there is a difference between the way that men and women think, whereas here in the United States, that question is raised often and is an area of active research.
I spent most of my life in the suburbs and in predominately white schools. My white classmates asked me every possible question about being black. These questions were the source of my inspiration. *It’s Because You’re White* addresses the insecurities two college students face in their pursuit of having a functional relationship despite their different races. With moments of comedy and honesty, the play addresses the stereotypes that black and white people have about one another. The plots of many movies and plays that focus on romantic and platonic interracial relationships have a recurring theme—that black and white people want a better understanding of the other’s culture. But few movies and plays deal with the questions I had, such as “Why do I feel like I have to explain my blackness or give a lecture on the black community?” and “Why is it so hard for me to believe that people in this day and age aren’t capable of seeing past the pigmentation of my skin?” I explored these questions as I wrote the script, in turn exposing my personal insecurities on stage for all to see. With this script, I hope to motivate others to have continuing conversations about our differences—realizing that we can talk about the issues that make us the most uncomfortable, so that one day, ignorance and racism will be a thing of the past.

**Preserving Identity**

Literature can show us how humans create identity. I explored how author O. E. Rølvaag constructs Norwegian-American ethnic identity in his book *Giants in the Earth*. He does so through the tormented character of Beret Holm, a pioneer woman who attempts to move back toward the original culture of her homeland. I suggest that Beret’s reaction to her new life in America represents Rølvaag’s message of preserving one’s traditional culture. I argue that Rølvaag’s description of Beret’s tragic state of ethnic identity is part of his larger political purpose in warning his Norwegian-American audience against forgetting their heritage. I characterize Beret’s state of ethnic identity as “reactionary traditionalist,” meaning that she yearns to be Norwegian in America when she can only be Norwegian-American. As long as Beret thinks of herself only as

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Preserving Identity (continued)

Norwegian and does not assimilate the American landscape into her identity, she will be doomed to depression and hopelessness. Giants in the Earth dwells in the regretful space between Old World and New World: when one yearns for the impossible past, yet can only move into the future. Although my project focused on Norwegian-American ethnic identity in a specific historical period, the study methods apply to many ethnicities over time. Even if we haven’t experienced immigration, we can identify with Beret’s struggle to belong and find a home in a strange new world.

Asexual propagation is a process in which plant growers cut multiple shoots from mother plants and then replant these shoots to grow new, identical plants. Introducing propagated petunias into the market was associated with increased reports of viral infections, including tobacco mosaic virus (TMV). TMV infects many plants and is spread by the tool that plant growers use to cut shoots from mother plants. Sterilizing tools is critical to prevent the spread of TMV, but at this time, no disinfectant does an adequate job of sterilizing cutting tools. TMV can survive for months on cutting tools and in plant debris. An outbreak of the virus can spread quickly and devastate entire crops, causing serious financial losses for greenhouse owners. I tested various disinfectants at different concentrations and at various lengths of time that the chemical was in contact with tools. I aim to determine the most effective disinfectants to prevent the transmission of TMV.

Staying Clean in the Greenhouse

Amanda Hayes, ’08
Plant Health Management
Advisor: Dr. Dennis Lewandowski

Project Title
Greenhouse Sanitation: Efficacy of Disinfectants on Cutting Blades using Tobacco Mosaic Virus on Petunia as a Model
In 2003, The Ohio State University chapter of the Christian Legal Society (CLS), a national religious organization of law school students, faced the possibility of losing its status as an officially recognized student group because it refused to abide by the university’s non-discrimination policy in regard to religion and sexual orientation. In response, the organization filed suit against the university claiming that the school was violating the group’s Constitutional rights to choose members. The university ultimately settled the case by creating an exemption for religious groups; those groups could discriminate on the basis of sexual orientation, creed, and religion. I studied the legal arguments for both the university and the CLS as I tried to determine what the outcome could have been had the case proceeded to trial. I analyzed the decision-making process to provide an explanation for how the university reached its decision to create the exemption. It appears that the law was uncertain on this issue and the university had a potentially winnable case had it gone to trial. This suggests that there were non-legal influences that played a role in the decision to settle. This case study can help us understand the intricate balance between religion and equality in the legal system today and what universities are able to do to protect all students’ Constitutional rights.

A staggering 85 percent of all traffic fatalities worldwide occur in developing countries. The fatality rate increases to 96 percent among children. Pedestrians, cyclists, and bus passengers are most affected by traffic-related injuries and deaths in developing countries. I collaborated with researchers in a rural area of Hunan Province in China, where we surveyed 1,500 students. We looked at psychological risk factors that could increase the chance of injury. These factors included lack of sleep and school-related stress. We also asked the children if they had ever been hit by a vehicle while they were either walking or riding a bicycle. We found that 56 students had been struck within the three-month study period. The majority (80 percent) of these children were struck by motorcycles. While we didn’t find a strong relationship between children’s sleep patterns and stress related to school, traffic injuries will remain a significant health problem throughout the developing world unless public awareness and research lead to improved prevention and treatment.
Atlantic tropical cyclones (commonly called tropical storms and hurricanes) usually form over water warmer than 26.5 °C (80 °F), a value widely considered the threshold for tropical storm development. However, the number of late-season formations has increased during the past 30 years; these hurricanes frequently occur over water cooler than 26.5 °C. I am studying how tropical cyclones develop over cold water and specifically the process of tropical transition (i.e., how an existing non-tropical cyclone becomes tropical). For my senior thesis, I looked at tropical cyclones that form in October, November, and December over the Atlantic Ocean north of 20N and east of 60W. I examined local wind data for 20 systems that formed between 1975 and 2005. I also studied sea surface temperature (SST) data for 15 systems that formed during the 24 hours prior to their designation as a tropical cyclone of an intensity greater than 33 knots. The average SST under the 15 systems was 24.7 °C, almost 2 °C colder than the threshold.

Changes in wind speed and direction with height—or wind shear—varied widely, though most values were relatively high. These data suggest that tropical cyclones can indeed develop over waters much cooler than the historical threshold and that the normal tropical development model does not apply.
I studied the effects of pomegranate seed oil on muscle tissue in mice. The oil contains punicic acid, a dietary fatty acid that may promote weight loss, increase quadriceps muscle mass, and decrease inflammation in muscle tissue. To test the effectiveness of punicic acid as a weight loss supplement, I conducted experiments in which I fed mice diets that included different levels of the fatty acid. Contrary to my expectations, the mice fed the most punicic acid gained the most weight and lost the most muscle mass during the 16-week feeding study. These mice also had much higher levels of punicic acid in their muscle tissue. Given the results of my study, punicic acid would be a more effective ingredient in the feed industry than in a weight loss regimen, yet further studies are being conducted to investigate the effects of this dietary oil. Understanding the mechanism of punicic acid and its effects on fat and muscle tissue may ultimately improve recommendations for those battling obesity or muscle degeneration associated with numerous diseases.

I use computers to gain a better understanding of how humans use language. I do so by using a statistical technique called constituency parsing, which is the process of computing some of the relationships between the words in a sentence. Constituency parsing assigns a label to phrases within a sentence. For example, the sentence “The farmer likes ice cream” has several subparts (called constituents), and each receives a label. “The farmer” and “ice cream” are noun phrases, while “likes ice cream” is a verb phrase. I use an algorithm—a set of rules for solving a problem—to look at thousands of sentences that other researchers have given these sorts of labels to in order to find new and more useful labels for the subparts. It turns out that noun phrases in some parts of a sentence (e.g., right after a verb) are statistically different from noun phrases in other parts of a sentence (e.g., right at the beginning of the sentence). This difference matters because after we changed the labels in the grammar, our parser became more accurate. These parsing experiments may help us gain a better understanding of how human brains create and store knowledge about language.
Economists often deal with bundles of goods. A house, for example, is a bundle of goods—it has a certain number of bedrooms, bathrooms, square feet, etc. Economists are interested in finding the value of each attribute: How much is an additional bathroom worth? How does location affect price? Hedonic price analysis looks at the effects of each attribute in a bundle of goods to answer such questions. I used this method to evaluate transactions on eBay for tickets to the 2006 Ohio State vs. Michigan football game. By analyzing 1,009 completed online transactions, I discovered important factors that determined per-ticket price. The results suggested that a seat’s price is determined by both its distance to the field and its line-of-sight to the middle of the 50-yard line. Fans were willing to accept a seat further from the field if it allowed for a better line of sight and vice versa. One of the most interesting findings is the social aspect of the game. Buyers were willing to pay more per ticket to obtain more tickets in a group, suggesting that social influences also affect prices.

My research project revolves around a protein named p65. This protein inhibits muscle differentiation, or the change of a non-specific cell into a muscle cell. It binds to DNA and represses the expression of muscle proteins. Without these muscle proteins, nonspecific cells cannot become muscle cells. Why is this important? From a medicinal perspective, blocking p65 function has been offered as a therapy for people suffering from muscle-wasting diseases, such as muscular dystrophy and cancer-related cachexia. My project aims to discover how p65 inhibits muscle growth by focusing on amino acids, the building blocks of proteins. Discovering which amino acids are important for the function of p65 could provide useful information for developing better therapies.
We’re an interdisciplinary team of three architecture and three mechanical engineering students working together to design and build a small sustainable home, nicknamed the “pod” for its diminutive size of 125 square feet. We created an exhibit of the most current sustainable technologies to show the average person that being “green” does not have to be complicated or expensive, and can also be integrated into the house in a way that makes the additions interesting and aesthetically pleasing. The exhibit furthers the idea that sustainable living should no longer be the exception, but the norm. We conducted the project in three phases—research, design, and construction. We first investigated sustainable materials for the structure and the interior of the house. We then selected the systems that would supply the house with electricity, heat, water, and related amenities. The pod uses a variety of sustainable technologies, including solar power for energy, a solar hot water heater, gray water recycling, low-flow water fixtures, LED and natural lighting, and sustainable building materials. Once construction is complete, the pod will be displayed at the Center of Science and Industry (COSI) in Columbus, Ohio.
I studied two genes that play a key role in the development of breast and ovarian cancer. While genetic testing is used to determine if a patient has mutations in either of these genes, called \textit{BRCA1} and \textit{BRCA2}, genetic testing results can sometimes be inconclusive. That’s because a certain class of mutations, which may or may not cause cancer, can show up in test results. I studied this class of mutations, which are called variants of uncertain significance (VUS). VUS yield inconclusive and unhelpful results in genetic testing because it isn’t clear whether or not these mutations cause cancer. I used specific criteria, including personal cancer history and tumor pathology data, to classify VUS as dangerous or neutral. In one part of the study, my colleagues and I found that nearly two-thirds (21 out of 33) of unclassified VUS were neutral, or unlikely to cause cancer. The classification of VUS as deleterious or neutral will aid patient care, specifically improving future decision making regarding screening, prevention, and treatment.

Ohio has consistently ranked as one of the most polluted states in the country. As Ohio residents and students, we wanted to examine exactly how that air pollution affects our bodies. To do this, we collected very small particles, known as fine particulate matter, and exposed a group of mice to the pollution. After a few months of exposure, we analyzed the mice to see what kind of effects the air pollution had on their cardiovascular systems. Mice exposed to the air pollution showed increased inflammation, and even developed symptoms typical of type 2 diabetes.
My thesis is a collection of five nonfiction stories surrounding a theme of family and personal identification between socioeconomic class, religion, and culture. Through these stories, I have walked the streets of North Philadelphia with my 15-year-old father and felt the weight of crime, of guns, of sidewalk and city skylines. I looked back at my grandmother, Joan, a glamorous woman who kept vintage jewelry and painted, yet was an alcoholic with the laugh of a witch, hoarding fiber optic angels in her bedroom before succumbing alone to dementia and death. I next stepped through my mother’s childhood home in Ohio, as seen from an out-of-towner, a carbon imprint of her, but still a stranger. My grandfather then led me into the dark foxhole where he was captured in the Battle of the Bulge, let me feel his hunger in the prison camp, and march with him through the German winter. Through the last story, I discovered what it meant to be “family” as an East Coaster with half a Midwestern family, never truly feeling like either. I have met the trail of prejudice from both regions and experienced the hidden cultural line that divides part of the United States.