

# undergraduate research

*at the state capitol*



*January 22, 2004 | Utah Capitol Rotunda*

**UtahState**  
UNIVERSITY





# Welcome!



On Behalf of Utah State University, I welcome you to 2004's Undergraduate Research Day on Capitol Hill. Each year, students from throughout Utah gather at the state capitol rotunda to share a year's worth of hard work and discovery with their peers and the rest of the state. These students truly represent the finest young minds in Utah, from St. George to Salt Lake to Smithfield.

I invite you to experience firsthand the outstanding efforts of these students. Their interests are diverse, ranging from plant biology and disease epidemiology to business forecasting and environmental engineering, yet each of their projects contributes to our collective body of knowledge and our ability to address real-life issues.

The findings of these projects will be far-reaching. Some of them will be published in academic journals, while others will be presented at national research conferences throughout the country. Many of them will be used to solve practical problems by guiding action on community and state issues.

At the same time, these students have been well-primed to achieve even greater intellectual, practical, and personal accomplishments in their bright futures. By honing their inquisitive instincts and scientific skills, they will be prepared to make significant contributions to the state's active economy and intellectual capital.

Strong undergraduate research programs are an invaluable asset to the state: they provide unparalleled educational opportunities for Utah's deserving students, and they create technologies, jobs, and skilled professionals for the statewide economy.

Thank you for taking time out of a very busy schedule to visit with these stellar students. We appreciate your support of Utah State University.

Sincerely,

Kermit L. Hall  
President

## Greetings!



In July of this year, a team of USU students realized a dream as they saw their creation, the USU Wright Flyer, soar over Huffman Prairie Flying Field, near Dayton, Ohio. The Flyer, a replica of the Wright brothers' contraption constructed with modern materials, is one of the few replicas that can actually fly and was the first to do so over the field where the original flyer had taken off 100 years before. The USU Wright Flyer, a student research project, is a national success.

Utah State University's tradition of research predates Orville and Wilbur's first flight. For 115 years, students have been learning by doing at USU and have used research to challenge their intellect, bolster their skills, and enrich their college experience with a rewarding sense of academic and personal accomplishment. At this year's Undergraduate Research Day on Capitol Hill, we invite you to explore the outstanding projects of student researchers. You'll learn about students who are:

- Gaining a better understanding of factors relating to autism
- Developing tests and therapies for dangerous viruses
- Testing Web-based systems for people with disabilities and their families
- Helping K-12 students to send their own experiments on the International Space Station

These projects are a boon to learning and discovery for Utah State students. Such projects also provide benefits to the community and state by creating solutions to practical problems and by nurturing the next generation of citizen scholars. Our faculty and students are in partnership to continue the USU tradition that started over a century ago. As a top research university, we commit ourselves to increasing our standard of research excellence for our students, faculty, community, and world.

Learning, discovery, and engagement go hand-in-hand at USU. Thank you for your interest in our students' research.

Best Regards,

Brent C. Miller, Ph.D.  
Vice President for Research

## About Undergraduate Research at Utah State



When we think about undergraduate research at Utah State we think invaluable. Just as Lara B. Anderson, recently selected as one of 32 Rhodes Scholars, stated: "I can't say enough good things about undergraduate research. It was everything for me, and it got me to where I am

today." Lara's research with faculty mentors in Physics and Mathematics resulted in her selection as a Marshall Scholar as well as a Rhodes. In 2003, Lara shared her research on biconformal supergravity with legislators in the State Capitol Rotunda. Who knows if the next Rhodes Scholar from Utah is in the Rotunda in 2004!

Our successes occur not just with an undergraduate researcher being awarded one of the most prestigious fellowships in the world. Consider these:

- Utah State had more students invited to present at the Council on Undergraduate Research's Posters on the Hill in Washington, DC in 2003 than any other university or college.
- Utah State students have sent more experiments into space than any other university in the world; the Get Away Special Project celebrated its 20<sup>th</sup> anniversary in 2003.

Utah State believes that research is invaluable for a student's intellectual growth and development. Students can begin working on research projects with faculty mentors as early as their first year at Utah State, investigating topics as diverse as ceramics, cardiac protein structures, carbon in soils, consumer bankruptcy, and cloning.

Invaluable? Yes, to the students, to their communities, and to the world. Utah State students truly make a difference.

Sincerely,

Joyce Kinkead

Vice Provost for Undergraduate Studies and Research

## [Thanks]

Special thanks to **Aaron Brown** and **Brandt Esplin**, undergraduate assistants to the Vice Provost for organizing this event.

Cover art by **Alan Hashimoto**,  
Faculty Member, Department of Art

Booklet compiled by  
**Anna Brunson McEntire**

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# Confirmation of *Poa* Hybrids and Transgene Movement from *Poa pratensis* L.

**amy anderton**

Logan, Utah  
*Student Researcher*



**paul g. johnson**

Department of Plants, Soils,  
& Biometeorology  
*Faculty Mentor*



**steve larson**

Department of Plants, Soils,  
& Biometeorology  
*Faculty Mentor*



Kentucky bluegrass (*Poa pratensis* L.) is grown all over the world because of its superior turfgrass qualities. Improvement in weed control is of interest to some turfgrass managers, and a privately owned company is trying to meet their needs by developing lines of *Poa pratensis* that are resistant to glyphosate, the active ingredient in Round-Up®, a very efficient herbicide. In order to provide it to the market and address regulatory questions, gene flow needs to be studied between the transgenic *Poa pratensis* and other *Poa* species.

In order to meet these research needs, a study was conducted to measure rates of gene flow. Seed was harvested from a number of *Poa* species in the study and screened for resistance to glyphosate. My work is the final step that confirms that the putative hybrid seedlings (1) have the glyphosate resistant gene and (2) that these seedlings are, in fact, hybrids between the transgenic bluegrass and another *Poa* species. The combination of these proves gene movement within the study.

Using polymerase chain reaction (PCR) methods to amplify (or make more copies of) a segment of the glyphosate resistance gene with two sets of primers, 35S and NOS, I confirmed that the glyphosate gene was in each putative hybrid. To each

putative hybrid is indeed an offspring from the transgenic bluegrass and another *Poa* species, and not seed contamination, I used the chloroplast genome (cpDNA) for identification. CpDNA is inherited through the maternal side only, making identification of the maternal parent easy for each putative hybrid. A segment of cpDNA (ndhF gene) was amplified using PCR with a ndhF primer and then sequenced.

Most of the putative hybrids are confirmed as being offspring from a cross between a transgenic *Poa pratensis* and a maternal *Poa* species. The rest of the putative hybrids are more difficult to confirm because both of the parents were *Poa pratensis*, causing them to be genetically similar, and therefore closely related. Because of this genetic similarity, I am now sequencing different genes using similar methods to confirm these additional hybrids. This investigation is needed to see if newly introduced genes could contaminate the natural species and bring in new phenotypic characteristics. This research will contribute to the overall study of gene flow with transgenic grasses and other *Poa* species and aid in the future studies of genetic engineering with grasses.

# Bringing Out-of-this-World Opportunities to the Student

**andrew auman**

Logan, Utah  
*Student Researcher*



**jan sojka**

Department of Physics  
*Faculty Mentor*  
*2002 Utah Professor of the Year*



Educators are always looking for new ways to better prepare their students for the future and life in the real world. Improving methods of pedagogy, keeping subject material current, adapting to and implementing new technologies in the classroom, and providing hands-on experiences for the students are some of the ways used to achieve this. Since June of 2003, the Utah State University Get Away Special Research Team has been working on developing a program which, if accepted and adopted by NASA, will provide for K-12 and undergraduate students opportunities to place their own experiments on the International Space Station. If implemented, the opportunities students will have as they work together on brainstorming ideas for their experiment, designing the experiment, flying the experiment in space, and then analyzing the results of their experiment will provide them with unparalleled experiences, helping educators achieve their goals.

# Genotyping of Single Nucleotide Polymorphisms (SNPs) Associated with Deafness



**ryan bair**

North Logan, Utah  
*Student Researcher*



**anthony r. torres**

Center for Persons with Disabilities  
Department of Biology  
*Faculty Mentor*

Deafness represents the most common newborn disability, affecting about 3 individuals/ 1,000 births. It is very important from a medical point of view to detect infants with hearing loss as early as possible, as intervention with hearing aids makes a significant difference in language development. Recent advances have shown that about 60% of hearing loss is inherited. Over the last ten years, the inherited mutations have been determined to be dominant, recessive, X-linked or mitochondrial. Despite the fact that more than 20 genetic loci have been described a single locus, DFNB1, accounts for about 50% of genetic deafness. The gene involved in this type of deafness is GJB2, which encodes the gap junction protein connexin 26(Cx26). It has been difficult to test large numbers of subjects to unravel the genetic complexity due to limitations in current genetic procedures. The problem can be attacked most readily by creating a large-scale project involving genotyping of thousands of individuals for

deafness-associated alleles. Birth blood spots are ideal samples as there is no additional risk to the subject and samples are taken on all newborns. However, blood spots only contain minute amounts of DNA that is insufficient for complex genotyping. This problem can be solved using a revolutionary DNA amplification system known as MDA developed in the laboratory of Dr. David Ward at Yale University. MDA can amplify minute amounts of genomic DNA (1ng or less) without significant allelic loss. The average size of the amplified DNA is over ten times longer than other amplification procedures. Using these techniques, our laboratory at USU has accomplished genotyping of the very complex HLA alleles and cytokines SNPs. It is our goal to apply this exciting technology to type thousand of samples from newborn blood spots to better understand the genetics of deafness and routinely use the typing for newborn infants.

## Confirmation of the C4B Null Allele in Subjects with Autism by Real-Time PCR



**brent bedke**

Sandy, Utah

*Student Researcher*



**anthony r. torres**

Center for Persons with Disabilities

Department of Biology

*Faculty Mentor*

In spite of 60 years of research, autism remains a perplexing disorder. Although no etiology has been discovered, it is well accepted that autism has a strong heritability as shown in twin studies. Our lab at USU has published over 25 manuscripts describing autoimmune characteristics in autism. An important study done several years ago indicated a strong association of the C4B null allele in subjects with autism. These interesting results have been confirmed recently in a study with different subjects from Utah and Oregon. This observation is significant as null alleles of C4 proteins have been associated in several autoimmune diseases. It is now important to test this finding in a large-scale study. However, protein allotyping is time-consuming, requires special sample preparation and is difficult to perform. The most convenient way to test this sample would be to genotype the C4 loci instead of allotyping C4 plasma proteins. The extraordinary complexity of the C4A and C4B genetic loci has made genotyping a very difficult procedure that is time consuming and requires rather large amounts of genomic DNA. Our laboratory at Utah State University along with Frank Spangler at Ameripath Technologies have developed an accurate method for determining C4A and C4B null alleles using fluorescently labeled oligonucleotides by Real-Time Polymerase Chain Reaction methodology. Preliminary studies show that C4A and C4B null alleles can be detected in many haplotypes and we are currently attempting to type complicated rare haplotypes. This new procedure will allow for important studies not only in autism but also autoimmune diseases and tissue transplantation.

# Stream Water Chemistry Differences in Watersheds of Varying Forest Cover and Lake Abundance

**phil brown**

Salt Lake City, Utah  
*Student Researcher*



**wayne wurtsbaugh**

Department of Aquatic, Watershed,  
& Earth Resources  
*Faculty Mentor*



Atmospheric nitrate deposition is an increasing problem throughout the American West. Nitrate-rich emissions from the burning of fossil fuels can be deposited in pristine mountain watersheds via rain and snow. Nitrate is capable of moving freely through the soil and entering surface water such as streams and lakes. Nitrate enrichment of surface water spurs the rapid growth of algae, clouding the clear, unproductive (oligotrophic) lakes and streams, altering the aesthetics and ecology of the waters. The land cover characteristics of a watershed (i.e. the percentage of land covered by forest or bare rock) can have a significant impact on the amount of nitrate and other nutrients that are released into the streams and lakes. Watersheds with relatively low areas of forest and high areas of bare rock will leach more nitrate into the surface waters, as the vegetation and soil microbes present in forests are able to uptake the nitrate.

Twelve small watersheds within the Sawtooth Mountains of central Idaho were sampled in this study. Each watershed has varying percentages of forested and bare rock area, and varying numbers of lakes. Water samples were collected from the inflow and outflow streams of the last lake in each watershed, and will be analyzed to determine how varying land cover characteristics affect the levels of nitrate and other nutrients in surface waters. Water samples will be analyzed for nitrate, phosphate, ammonium, and carbon. Analysis is expected to take place in late December 2003.

# Historical Biogeography of Native South American Aphids



**danica daly**

Centerville, Utah  
*Student Researcher*



**carol von dohlen**

Department of Biology  
*Faculty Mentor*

The aphid subfamily, Aphidinae, is a species-rich lineage of plant-feeding insects with an overwhelmingly northern-hemisphere distribution, containing a number of serious agricultural pests. Over 99% of Aphidinae species are native to the northern hemisphere, where they feed faithfully on plant lineages with high species diversity in the northern hemisphere, such as grasses (Poaceae), composites (Asteraceae), the carrot family (Apiaceae), and the rose family (Rosaceae). The traditional view of Aphidinae evolutionary history presumes that this subfamily originated and diversified in the north-temperate zone and that the ~ 1% of species native to the southern hemisphere are recent emigrants from the north. A more recent study of phylogenetic relationships that incorporated northern-hemisphere species and New Zealand endemics challenged this view, because it suggested that southern-hemisphere species might be much older than previously thought, 15-30 million years old. This study further tests the relationships and ages of southern taxa by obtaining and incorporating species native to South America (Argentina) in a phylogeny of Aphidinae. Data for this study were drawn from sequences of the nuclear gene, elongation factor-1a, and the mitochondrial genes, cytochrome oxidase II and the leucine transfer RNA. Phylogenetic relationships were reconstructed with Paup\* 4.0, using maximum parsimony and maximum likelihood. If southern Aphidinae were truly descended from old, indigenous ancestors, then species from Argentina and New Zealand should be most closely related, and perhaps form the most basal (oldest) lineages of the tree. Such a result might even suggest that Aphidinae originated in the southern hemisphere and that the bulk of its diversity is due to a few timely dispersal events to the northern hemisphere.

# Business Outlook for U.S. Firms in Vietnam

**michael degasser**

Mendon, Utah  
*Student Researcher*



**vijay kannan**

Department of Business Administration  
*Faculty Mentor*



Vietnam has received great interest by U.S. firms for business and trade opportunities. A large portion of this interest has been stimulated by the recent Bilateral Trade Agreement between the U.S. and Vietnam. The current and continuing changes have caught the eyes of many U.S. firms. This study will take an in depth look into three main factors which have a powerful influence into trade and business for U.S. firms in Vietnam. The first factor to be looked at is politics. There have been essential political reforms and changes in Vietnam in the past decade. In the 1990's, the "doi moi" political reform and in December of 2001, the implementation of the Bilateral Trade Agreement with the U.S. have both been significant political reforms affecting the business and trade potential. The second factor to look at is economic conditions, both the economic climate and the trade infrastructure. With foreseeable opportunities which lie within the country there have been large amounts of foreign investment. The economic reforms brought about by the government have created an increasingly stable economy and improvements within the infrastructure. Thirdly, the last factor to be looked at is available resources within the country. Vietnam has many undeveloped resources. These resources include human capital, mineral, and agricultural resources and have exceptional potential gains for U.S. firms. The results of this study show how the three main factors discussed are a positive influence on the business potential in Vietnam. As business continues to become increasingly globalized this study will contribute to those firms who are seeking new business opportunities in foreign markets.

# Abnormal Expression of HLA Proteins in Brain Cells of Austistic Subjects



**douglas durrant**

Salem, Utah  
*Student Researcher*



**anthony r. torres**

Center for Persons with Disabilities  
Department of Biology  
*Faculty Mentor*

The Department of Education annual reports to the US Congress showed a 435% increase of autism in the United States from 1992/1993 to 1999/2000. Even though diagnosis of autism may be becoming more definitive, still little is known about autism and its underlying molecular implications. The CPD laboratory at Utah State University has published several papers showing major histocompatibility complex (MHC) associations with autism. Recently data has been published that suggests that the HLA-DR (DR4) and DR13 alleles are linked to autism spectrum disorder (Torres, 2002). In addition to the obvious autoimmune connections, MHC proteins are important in neuronal plasticity and synaptic modification. This project involves the comparison of cell surface MHC proteins and protein identifiers between brain section from subjects with autism and normals by immunohistochemical methodology. Results will show whether there is an autistic neurodevelopmental disorder pattern affecting the brain. Procedural techniques will be worked out first on brain slices from an autistic newborn mouse model where the pregnant mothers were infected with influenza virus (Patterson, 2002). Following these studies, post-mortem brain slices from the human brain will be investigated for MHC differences. This project is a collaborative effort among Drs. Torres, Ward and Patterson at Utah State University, Yale University and Cal Tech respectively.

# Evaluating the Efficiency of Service Coordination for Infants and Toddlers with Special Needs

**melissa gordon**

Castle Dale, Utah  
*Student Researcher*



**emily nordfelt**

Bountiful, Utah  
*Student Researcher*



**diane behl**

Early Intervention Research Institute  
*Faculty Mentor*



**richard roberts**

Early Intervention Research Institute  
*Faculty Mentor*



This study uses innovative methodologies to determine the efficiency of service coordination provided to infants and toddlers with disabilities served by Part C, IDEA. Approximately 210 families and 100 providers/administrators from six states are participants. Service coordinator time diary logs and cost data are being compared to services provided as well as family quality of life measures to determine the efficiency of service coordination. As undergraduate students, we have been involved in data collection and follow-up as well as assisting in the analysis of service coordinator and family data. This poster presentation will provide a comprehensive description of the methodologies used in this study that determine the effectiveness of service coordination provided to infants and toddlers with disabilities. Preliminary data showing variations across models will be presented. This study will provide policymakers, providers, families, and researchers with a comprehensive picture of the benefits and drawbacks of service coordination models, enhancing their ability to select the model that best meets the needs of children and families while attending to efficient use of funds.

# Environmental Factors Affecting Natural Attenuation of MTBE and TBA at a Full-Scale Site



**mark greenwood**

Draper, Utah  
*Student Researcher*



**ronald sims**

Department of  
Biological & Irrigation Engineering  
*Faculty Mentor*



**ryan dupont**

Division of Environmental Engineering  
*Faculty Mentor*

Researchers at the Utah Water Research Laboratory, Utah State University, are collaborating with the Center for Biofilm Engineering at Montana State University and the Montana Department of Environmental Quality to evaluate monitored natural attenuation (MNA) of methyl *tert*-butyl ether (MTBE) and tertiary-butyl alcohol (TBA) at a gasoline contaminated site in Ronan, MT. MTBE is a fuel oxygenate used to reduce carbon monoxide and ozone emissions from internal combustion engines. TBA is one of the first intermediates produced during aerobic biodegradation of MTBE. This research has resulted from concern over the recalcitrance and potential health risk associated with MTBE and TBA in the subsurface.

The MTBE contaminated site in Ronan, MT has been studied in regard to the effect many environmental factors by various researchers. Results of mineralization experiments using sediments and microorganisms from the groundwater environment at the Ronan, MT site will be described. The MTBE plume extends 600 m from a leaking underground storage tank.

toward a spring creek, where ppb levels of MTBE have been reported. MTBE concentrations are observed to decrease sharply where the anaerobic groundwater comes into contact with the aerobic surface water. Sediment microorganisms and aqueous microbial cultures were incubated aerobically at a temperature related to the site at 1 mg/L concentrations. Samples were spiked with [U-<sup>14</sup>C] TBA and [U-<sup>14</sup>C] MTBE and <sup>14</sup>CO<sub>2</sub> evolution was measured as a function of incubation time.

This study also investigates the sorption characteristics of MTBE and the degradation intermediate TBA to sediments collected at the site. The concentrations used correlate with those found at the site (0.01 mg/l to 1.00 mg/L). The samples were spiked with [U-<sup>14</sup>C] TBA and [U-<sup>14</sup>C] MTBE, and concentrations of both measured in the aqueous and soil phases. These relationships were used to evaluate the potential for the application of monitored natural attenuation (MNA) for site remediation and for protection of the spring creek at the Ronan, MT site.

## Are Foods Feminine? Father-Toddler Play, Gender, and Toy Preference



**tyler hatch**

North Logan, Utah  
*Student Researcher*  
*Vice President for Research Fellow*



**lori roggman**

Department of Family, Consumer  
 & Human Development  
*Faculty Mentor*

Many infancy studies observe play as a “window” on early development using toys selected to appeal to both genders. Toy preference is affected by gender as early as one year of age, perhaps because of differences of interest or stereotypes learned while watching parents, siblings, and other children. This study examines simple relations between the gender of 2-year-olds and their toy preferences, reflected in the time they spent playing with particular toys during a father-toddler play observation. The research was conducted on 79 low-income fathers and their 24-month-old child (39 male, and 40 female) who were part of the local Early Head Start research. Fathers and toddlers were videotaped for 10 minutes. The time spent on various sets of toys was recorded. Results show that fathers and male children spent significantly more time on a set of toys with a pizza, cutter, plates, and phone than fathers and female children, which contradicts other studies showing that food and dishes were responded to as “feminine” toys and preferred by girls (Leaper 2000). However, this study supports other research indicating that male children are more likely to play with toys that elicit motion (i.e. pizza that you cut with a rolling pizza cutter) whereas girls are more attracted to items that involve nurturance. The toy food in this study may have been more salient as a motion toy than a nurturance toy. Overall, the study reinforces the idea that gender does affect father-toddler toy preference, but continuing research will allow us to see if mothers and toddlers of the same age show similar gender differences.

## "Mother's Club" in Peru

**jennifer hulse**

Mapleton, Utah  
*Student Researcher*



**bonnie glass-coffin**

Department of Sociology,  
Social Work & Anthropology  
*Faculty Mentor*



During a five week ethnographic field school in Huanchaco, Peru, I investigated the activities of a government-sponsored development initiative called a *Club de Madres* (Mother's Club). This small sector of a national organization, consisting of about sixty women, was originally organized by the government to provide food for the children of impoverished communities. The members of the club gather daily to communally prepare and distribute meals to poor children in the surrounding community as a sort of community kitchen. My research investigates their activities and also the physical, emotional, and financial hardships that are specific to women in this region and that negatively impact the success of this development initiative. These include domestic abuse, culturally established norms for women that *do not* encourage the sharing of their personal stories of suffering with other club members, difficulties maintaining the club, and poverty. The information I found as a result of this research is compared to other women's development and support programs I have investigated in the United States and in India. The poster provides both pictures and text detailing the research.

## Improving Family Services via a Web-Based Interagency Application Process



**matthew jenson**

Smithfield, Utah

*Student Researcher*



**joshua wheeler**

Smithfield, Utah

*Student Researcher*



**adrienne akers**

Early Intervention Research Institute

*Faculty Mentor*

Families who have a child with special needs often feel confused and overwhelmed when attempting to find services for their child. Many find the system to be a complex disconnected network that creates additional frustration. In our technically advanced society, it is unbelievable that the services available to families have not created an integrated approach for ensuring and providing services. The Opening Utah's Doors Project is developing a web-based interagency application process to assist families as they enter the service system. Web-based interagency applications are both promising and economical because no additional hardware is needed using this type of system beyond a computer with an Internet connection. The project is working in partnership with nine state agencies in Utah to develop an online process, called the Universal Application System (UAS). The strength of the UAS is that each agency's application is scanned *as is* such that the no changes to the existing requirements or wording are necessary. Because much of the information gathered on applications is duplicative the UAS asks questions

only once and then distributes the responses onto those applications that the client desires. The output includes completed applications on each agency's current application form, thus reducing the need for reinventing the wheel on the part of client and intake worker.

Using a participatory approach, project staff are conducting a series of pilot studies in several Utah communities to test the UAS. Each community team designed how families and agencies in their community will utilize the UAS. These community-based pilot studies will help to ensure the success of this type of systems change effort prior to introducing an interagency application process statewide. Data are being gathered from users to determine the length of time to complete the process, number of programs applied for, location where user completed the process (e.g. home, agency office, public library), and overall user-friendliness. Preliminary data indicate that families find the process to be helpful, easy-to-use, and convenient.

## Adult Attachment and Marital Conflict



**cheryl jones**

Providence, Utah  
*Student Researcher*



**thorana nelson**

Department of Family, Consumer  
& Human Development  
*Faculty Mentor*

How do adult attachment styles apply to marital adjustment? What assessment are used and what interventions are available for overcoming marital problems related to attachment issues? An extensive literature review covers the theory of attachment as studied by John Bowlby and Mary Ainsworth. It covers the characteristics of secure attachment, avoidant attachment, and resistant attachment. These attachment styles in infants can be applied to attachment styles in adults. There is research to suggest that attachment styles in adults have an effect on marital adjustment. It reviews different attachment style and marital conflict measures. It will also look into how attachment processes in adults play into couple and family therapy. A thorough review of the effectiveness of emotionally-focused therapy will also be looked at. The purpose of this research is to determine whether or not attachment styles in adulthood have an effect on romantic relationships and how they can be helped in therapy. It tries to find if correlations between certain combinations of attachment styles in couples are related to better marital adjustment. It will look at the effectiveness of couple therapy and how it can help marital conflict by using an emotionally-focused approach or by looking at the solution through the context of attachment styles.

# Family Size in Relation to a Mother's Supportive Presence

**danielle kraus**

Vernal, Utah  
*Student Researcher*



**lori roggman**

Department of Family, Consumer  
& Human Development  
*Faculty Mentor*



**deann jones**

Department of Family, Consumer  
& Human Development  
*Graduate Student Mentor*



It is a common assumption that the quality of parenting decreases when family size increases. With large families, mothers are often less responsive and supportive of children. Family size is often correlated with low income and poor education. In Utah, however, there are high education and literacy levels, even among poor families with many children. Exploring the relation between family size and parenting in Utah provides information about how culture influences parenting. Participants were 124 low-income families (mean income = \$11,415). The number of children in the home ranged from 1 to 7 (mean = 2.48). Videotaped observations of mothers and children working together on a puzzle were obtained when children were 36-months old and prior to kindergarten entry. Supportive presence of the mothers was coded based on overall ratings of cognitive stimulation, sensitivity, and positive regard. Results contradicted the expectation of negative effects of family size on parenting. As family size increased, supportive presence was greater at 36 months,  $r = .23$ ,  $p < .05$ , and pre-kindergarten,  $r = .22$ ,  $p < .05$ . This indicates that having many children does not interfere with positive parenting in this sample. Many residents of Utah choose to begin their family before they have acquired employment to provide adequate income. Pathways into poverty and opportunities to escape may be different for these families than for other low-income families. As a result, family size may have a different meaning in this culture.

# Molecular Phylogenetics of Velvet Ants (Hymenoptera: Mutillidae: Sphaerophthalminae)



**scott larsen**

Sandy, Utah  
*Student Researcher*



**danica daly**

Centerville, Utah  
*Student Researcher*



**carol von dohlen**

Department of Biology  
*Faculty Mentor*



**james pitts**

Department of Biology  
*Faculty Mentor*

Velvet ants are solitary wasps in the family Mutillidae. They are parasitic on important pollinators such as bees and wasps. The family is found worldwide, includes over 8000 described species and is split into seven subfamilies. Currently, two different phylogenies exist for the subfamilies making some of their relationships questionable. The largest subfamily is the Sphaerophthalminae, which incorporates approximately seventy genera found in the New World. The subfamily is predominantly diurnal and these species are normally aposomatically colored. Nine genera are nocturnal, but it remains unknown how these genera are related and how many times nocturnality evolved in this subfamily. Regardless of when they are active, there is a significant difference in male and female morphology making it difficult to associate male and female of the same species. This has created a taxonomic dilemma because many species are described by a single sex. Along with these species-level problems, generic relationships within the Sphaerophthalminae are also unknown. Our research will elucidate relationships for the family at the subfamily level and for the Sphaerophthalminae at the generic level. These relationships will be derived through comparisons of molecular data taken from mitochondrial and nuclear genes. Our research will also clarify taxonomic discrepancies between single-sex species. We will also determine the multiplicity of evolution of nocturnality by including nocturnal genera in the analysis.

# Analysis of the HLA Region in Subjects with Pediatric Autoimmune Neuropsychiat- ric Disorders Associated with Streptococcal Infections (PANDAS)

**kent lofley**

Elmo, Utah  
*Student Researcher*



**anthony r. torres**

Center for Persons with Disabilities  
Department of Biology  
*Faculty Mentor*



The Center for Persons with Disabilities at Utah State University is collaborating with Dr. Susan E. Swedo from the National Institute of Mental Health to evaluate the possible genetic markers associated with pediatric autoimmune neuropsychiatric disorders associated with streptococcal infections (PANDAS). PANDAS are seen in a subgroup of prepubertal children who had an abrupt onset of obsessive compulsive disorder (OCD) following an infection with Group A beta-hemolytic Streptococcal bacteria (GABHS). Genetic testing is underway to assess especially the TNF-alpha promoter region and numerous cytokines found in PANDAS patients. PANDAS and OCD are believed to be autoimmune in origin. Essentially all autoimmune disorders associate with genetic loci contained in the human leukocyte antigen region (HLA) on the short arm of chromosome 6. We are examining loci in all three regions of HLA. Class I and Class II genes encode proteins important in antigen presentation and class III C4 genes encode proteins.

# Detection of Proteomic Biomarkers in Plasma from Subjects with Autism by MALDI-TOF Mass Spectrometry Analysis

**cody mickelsen**

Aurora, Utah  
*Student Researcher*



**anthony r. torres**

Center for Persons with Disabilities  
Department of Biology  
*Faculty Mentor*

New methods combining molecular and statistical analysis are needed to develop biomarkers for disease diagnosis, prognosis as well as drug discovery. Two technologies showing great promise in fulfilling these needs for detecting biomarkers are being used in this in this project. The first involves the comprehensive determination of protein/peptide profiling by Mass Spectrometry (MS). Human plasma from subjects with autism has been examined by matrix adsorbed laser desorbed ionization time-of-flight mass spectrometry (MALDI-TOF) methodology that can simultaneously detect thousands of masses from 800 to 100,000 MW. We have data comparing spectra from plasma samples from subjects with autism and age matched controls from a less powerful MALDI-TOF instrument that detected masses between 800 to 3,000 MW. Analysis of the median spectrum from 47 autistic subjects and 20 age and sex matched control respectively indicate statistically significant differences in several molecules. Our main goal is to extend this work for the identification of biomarkers that can be used to detect autism in blood samples.

# The Development of an RT-PCR Assay to Determine the Potential Effectiveness of Unknown Anti-viral Agents

**garry miller**

Taylorsville, Utah  
*Student Researcher*



**joseph li**

Department of Biology  
*Faculty Mentor*



The Pichinde virus belongs to the Family *Arenaviridae*. Some members of this family including Lassa virus and others that can cause hemorrhagic fever. Thus, they are possible bio-terrorist agents. Good chemotherapeutics for this group as well as a reliable screening assay are currently unavailable. Using the Pichinde virus, experiments were performed to determine the potential effectiveness of some unknown anti-viral agents. A Real Time-Polymerase Chain Reaction assay has been developed and optimized to test potential and efficacy of anti-viral agents. The results of several anti-viral agents are presented.

# Monitoring Vertical Temperature Inversions in Cache Valley using HOBO® Temperature Sensors/ Dataloggers



**kori moore**

Logan, Utah  
*Student Researcher*



**randal martin**

Department of  
Civil & Environmental Engineering  
*Faculty Mentor*

In recent winters, Logan, located in Utah's Cache Valley, has experienced several episodes wherein the ambient concentrations of particulate matter less than 2.5  $\mu\text{m}$  in diameter ( $\text{PM}_{2.5}$ ) has approached or exceeded the new National Ambient Air Quality Standard. Although potential source strength is a strong contributor to the particulate concentrations, equally important factors are the inhibited dispersion and mixing caused by frequent low-level, wintertime inversions and the relatively closed nature of the surrounding topography. The Cache Valley has an area of approximately 300 square miles, with a base elevation around 4400 feet, and is bounded by mountains up to 9900 feet on the west, south, and east sides, creating a protected pocket. In the lower atmosphere, temperature usually decreases with increasing height; inversions occur when this trend is broken by a short increase in temperature. Dense, cold air is trapped below warm, light air, thereby inhibiting any vertical mixing, effectively forming a "cap" over the area of interest, trapping pollutants underneath. Inversion height and persistence are directly related

to particulate concentrations. Measurements of inversion heights are typically achieved by collecting vertical temperature profile data using periodically released radiosonde balloons or via tethered balloon sampling, but these techniques are time intensive, require costly equipment, and produce time-limited data. More time resolved measurements involve acoustic and thermal absorption techniques, but these methods require complex and expensive instrumentation. Beginning in the Spring of 2003, a series of nine inexpensive HOBO® portable temperature sensors/dataloggers were deployed at various elevations from the Logan city air pollution sampling site (ele. 4542 ft), along a ridgeline immediately adjacent to the city, to a final elevation of 6581 feet. The sensors continually collect hourly averaged data, which is downloaded monthly. Preliminary analysis clearly shows the existence of low-level radiation inversions, as well as diurnal and seasonal variations in the shape, longevity and steepness of the vertical temperature profile.

## Advanced Readers at Risk



**cynthia jane parke**

Centerville, Utah

*Student Researcher*

*Vice President for Research Fellow*



**scott hunsaker**

Department of Elementary Education

*Faculty Mentor*

Advanced Readers At Risk is a program designed to address the specific needs of elementary students who read well above grade level. Utah NAEP data indicated that by the end of 5<sup>th</sup> grade, 21% of students were reading well above grade level and 26 % of students were reading below grade level. These proportions are nearly equal, yet advanced readers are often ignored in schools where the usual focus is on basic reading skills. The main element of this project is the World Class Reader Model which is being implemented in elementary schools throughout Utah. This model consists of four components. Two of these components—Learning to Read and Reading to Learn—are designated as “academic reading.” The other two components—Reading for Leisure and Reading to Serve—are designated as “active reading.” The World Class Reader Model helps all students; however, the model describes specifically how it can be applied so it is challenging and complex to facilitate growth in students reading above grade level. The Advanced Readers At Risk program was approved in the 2001 legislative session and received an appropriation for grants in school districts. Current results indicate a positive impact on teachers in the recognition of advanced readers and in skills for addressing the needs of advanced readers.

# Mechanistic Studies of Phosphoryl and Thiophosphoryl Group Transfer

**jamie purcell**

Logan, Utah

*Student Researcher*



**alvan c. hengge**

Department of Chemistry

*Faculty Mentor*



Substitution of a sulfur atom for an oxygen atom in the phosphoryl group of a phosphate ester accelerates hydrolysis rates in monoesters, but suppresses triester hydrolysis. Thermodynamic investigations have been conducted to determine the enthalpic and entropic contributions to these effects. Phosphate monoesters react via a concerted  $A_N D_N$  mechanism, while phosphorothioate monoesters follow a dissociative  $D_N + A_N$  mechanism. Compared to the corresponding phosphate monoester, the phosphorothioate monoester hydrolysis reaction has a higher enthalpic barrier, but much more favorable entropy of activation resulting in a lower net activation barrier and faster hydrolysis. However, in phosphate triesters the slower hydrolysis rates observed with sulfur substitution result from higher enthalpic barriers, but are not offset by significant differences in entropies of activation. Triesters undergo hydrolysis by a mechanism with greater nucleophilic participation in a penta-coordinate transition state, resulting in entropies of activation much more negative than monoesters.

# The Embedded Ring Approach Applied to Annealed Graphitic Amorphous Carbon



**sterling smith**

Grantsville, Utah

*Student Researcher*



**jr dennison**

Department of Physics

*Faculty Mentor*

Determination of the nanoscale structure and bonding of atoms in highly disordered materials is extremely difficult, but essential in understanding these ubiquitous materials. We perform complex calculations that allow the determination of the medium range order of constituent atoms in graphitic amorphous carbon (g-C) by modeling its Raman spectra, which corresponds to the in-plane motion of atoms. Specifically, a dynamical model, the embedded ring approach (ERA), is applied to predict the evolution of vibrations and structure of annealed g-C. We find that the graphitic nature of g-C increases with annealing temperature as evidenced by a greater fraction of 6-membered rings and by sharper peaks in the Raman spectra.

# Internet Accessibility for People with Disabilities

**elaine watkins**

Salt Lake City, Utah  
*Student Researcher*  
*Vice President for Research Fellow*



**cyndi rowland**

Center for Persons with Disabilities  
*Faculty Mentor*



As our education system has come to rely on the Internet heavily, it is imperative that *all* people, including those with disabilities, are able to access the internet. In many instances, the Web is not accessible to people who have disabilities. It is often difficult for a person with a vision-impairment to navigate a website, a deaf person to fully comprehend a video clip, or someone with a motor disability to control a mouse or keyboard. All these people deserve an equal opportunity to engage in information gathering and communication via the internet. There are several simple methods to increase accessibility, but unfortunately, they are not always integrated into websites. This is in part due to poor knowledge about accessibility principles by the Web developer. In order to determine the typical knowledge of USU web developers regarding accessibility, researchers used a phone survey of a sample of those who develop web content at Utah State University. Questions began with their assignment as a Web developer and how experienced they were in the field. The main sections of the survey investigated their knowledge on the concept of making the Web more accessible to persons with disabilities. Overall, results of this sample indicate that many educational Webmasters engage in Web development on a part-time basis. Although many developers stated that they were aware of Web accessibility, few indicated that they had designed with accessibility principles in mind. Almost none of those surveyed could provide examples of accessibility tips or how to test to see if their site could be accessed by someone with a disability. If the results of this sample survey are indicative of the larger population of Web developers in education, action needs to be taken.

# The Influence of Non-Academic Factors on Academic Performance: A Test of the Jones and Pittman Taxonomy of Impression Management



**angela webb**

Bountiful, Utah

*Student Researcher*



**kenneth bartkus**

Department of Business Administration

*Faculty Mentor*

Theoretical developments in the area of impression management have shown that it influences a variety of work-related performance outcomes. For example, research has shown that job candidates who agree with the interviewer are seen as more competent. Other research has shown that individuals who self-promote are more likely to receive higher on-the-job performance evaluations and a have a greater likelihood of promotion. The major research question addressed in this study is whether or not the relationship between impression management and work-related performance outcomes is generalizable to an academic setting. Specifically, do non-academic factors such as impression management influence the academic performance of university students? To help answer this

question, a multi-dimensional scale was developed based on the Jones and Pittman Taxonomy of five forms of impression management: (1) Ingratiation - to be seen as likable, (2) Exemplification - to be seen as dedicated, (3) Self-promotion - to be seen as competent, (4) Intimidation - to be seen as threatening, and (5) Supplication - to be seen as in need of help. The major hypothesis is that a student's belief in these tactics helps explain variation in academic achievement. It is also hypothesized that the relationship is moderated by three motives: (1) goal relevance, (2) value of the desired impression, and (3) discrepancy between the desired and perceived image. Implications for the management of courses, including techniques for impression management detection, are provided.

# Importance of Microbial Conditioning to Allochthonous Breakdown Rates in Tropical Streams



**vanessa welsh**

Springville, Utah  
*Student Researcher*



**todd a. crowl**

Department of Aquatic, Watershed,  
& Earth Resources  
*Faculty Mentor*

Headwater streams rely on terrestrial organic matter (allochthonous inputs) as the energy basis of their food webs. Numerous studies have shown that microbial conditioning increases the palatability and breakdown rates of leaves in temperate streams that are dominated by small aquatic insect larvae. In tropical streams large macro-consumers such as the freshwater shrimp (*Xiphocaris elongate*) play an important role in those detrital food webs. Because of their large size, it is not known whether microbial conditioning affects their ability to break down allochthonous leaf litter or if condition affects the nutritional value or palatability.

To determine the importance of microbial conditioning, we first analyzed the source, quantity and species composition of allochthonous inputs into the Quebrada Prieta, a tropical headwater stream, in the Luquillo Experimental Forest, Puerto Rico. Our collection methods allowed us to determine what proportion of the allochthonous inputs originated from: 1) overhanging vegetation (no microbial condition); 2) overland sources such as stream banks (terrestrial microbial conditioning); or 3) from upstream transport (aquatic microbial conditioning). In terms of

biomass, the greatest amount of allochthonous inputs entering the study sites came through stream transport, which suggests that the majority of leaves in the sites available for consumption have been subject to aquatic conditioning.

To determine whether conditioning affected the rate of breakdown, four common species of leaves were experimentally conditioned by placing them in stream water, on the stream bank or suspended above the ground for two weeks. These leaves were then placed in small experimental mesocosms that contained freshwater shrimp obtained from a nearby stream. Leaf loss due to shrimp consumption was measured every four days for twenty days. Decay rates were measured and compared among treatments by first fitting negative exponential decay functions to the percent of the remaining biomass and then using analysis of covariance techniques to determine whether conditioning treatments differed with or without shrimp.

For all species, shrimp significantly increased the rate of decomposition or breakdown, independent of the form of microbial conditioning. As hypothesized, shrimp are much faster agents of breakdown than either microbes or insect consumers. For some species, aquatic conditioning resulted in faster breakdown by shrimp compared to leaves that were either not conditioned or were terrestrially conditioned. This suggests two possible mechanisms. Aquatic microbes could break down cell walls of the leaves making them easier to consume by shrimp. Alternatively, shrimp could be consuming leaves incidentally while consuming the aquatic microbes that are a common and readily food source on the stream bottoms. Under either circumstance, tropical stream systems may be operating somewhat differently than temperate systems due to the large-bodied decomposers found there.

# Iron Deficiency in Young-Adult Women Attending Utah State University



**caralee wilcock**

Taylorsville, UT  
*Student Researcher*



**noreen schvaneveldt**

Department of Nutrition & Food Science  
*Faculty Mentor*



**heidi wengreen**

Department of Nutrition & Food Science  
*Faculty Mentor*

Iron deficiency is the most common nutrition deficiency worldwide and remains a problem even among populations in developed countries. Prevalence estimates in at risk groups including toddlers, adolescent girls, and women of childbearing age range from 9-16%. In a sample of 23 women aged 18-38 enrolled in a junior level nutrition course at Utah State University, 12 had serum ferritin concentrations < 20 ng/mL, indicative of depleted iron stores. Among the 12 with depleted iron stores, 10 had iron deficiency anemia. A larger percent of iron deplete women compared to iron replete women reported feeling cold (73%, 46%), feeling weak (55%, 30%), having a loss of appetite (36%, 9%), having pale skin (27%, 0%), or craving non-food substances (27%, 9%) although due to small sample size

none of these differences reached statistical significance. Compared to iron replete women, iron deficient women started menstruating at an earlier age (13 vs. 14 yrs;  $p = 0.06$ ) and a larger percentage reported heavy bleeding during menstruation (67% vs 27%;  $p = 0.06$ ). Compared to iron deficient women, iron replete women consumed more total iron (11.4 vs. 10 mg/day), red meat (.22 servings/day vs. .20 servings/day), and a greater percentage took an iron containing multivitamin mineral supplement (36% vs. 0%). In conclusion, young-adult women attending school may be at increased risk of iron deficiency. Iron deficiency may have a negative impact on performance at work, home, and school. Increased consumption of iron in the form of food or supplements may work to decrease iron deficiency in this at-risk population.

# Richmond *Charette*: A Rural Design Vision for the Future



**kimberly m. williams**

Syracuse, Utah  
*Student Researcher*



**ladd b. schiess**

Smithfield, Utah  
*Student Researcher*



**neil miner**

Department of Landscape Architecture  
& Environmental Planning  
*Faculty Mentor*



**david bell**

Department of Landscape Architecture  
& Environmental Planning  
*Faculty Mentor*

At the beginning of the 2003 academic year, the LAEP (Landscape Architecture and Environmental Planning) Department participated in a design *charrette*. A *charrette* is a French term for an intense design session that originally ended with the gathering of student's designs in a cart. Nearly everyone in the department participated, including seniors, juniors, sophomores, faculty, and other advisors.

The *charrette* focused on Richmond City, Utah, and the design possibilities for its future. Richmond is a town in Cache Valley of Northern Utah. It is a classical example of a rural town that struggles to maintain its identity while allowing for economic development. The widening of Highway 91 was a catalyst for the *charrette* to occur.

The *charrette* focused on seven areas:

- the general plan
- rural community design,
- community parks, open space, trails, connections, etc...
- rural community identity
- rural community landscape
- access- community inclusion

At the end of an exhaustive week (most students stayed into the evenings) students' work was collected and combined into a master document and presentation given to Richmond.

# Aryloxymethano- and Aryloxyethano- Phosphonic Acids and Their Arylthio Analogues as Motifs for Inhibition of Phosphatases



**jarod younker**

North Logan, Utah  
*Student Researcher*



**alvan c. hengge**

Department of Chemistry  
*Faculty Mentor*

On the basis of knowledge of the transition state for enzymatic phosphoryl transfer from kinetic isotope effects and calculations, we proposed aryloxy (or thio) methyl and aryloxy (or thio) ethyl phosphonic acids of the general formula  $RX-(CH_2)_n-PO_3H_2$  (where  $X = O$  or  $S$  and  $n = 1$  or  $2$ ) as non-hydrolyzable mimetics of these transition states. Several simple prototype compounds were synthesized and tested against a panel of phosphatases: the protein-tyrosine phosphatase from *Yersinia*, the human and *E. Coli* alkaline phosphatases, and the Ser/Thr protein phosphatases PP2C and Lambda. The compounds exhibit competitive inhibition towards all tested enzymes, with the  $K_i$  values in the case of metallophosphatases (particularly Ser/Thr phosphatases) in the micromolar range. The inhibition constants with *Yersinia* PTPase are higher.

## Research at Utah State University--Building on a Tradition of Excellence

- 1888 Land-Grant College approved for Logan
- 1890 Classes began at the Agricultural College with 139 students (coed); curriculum emphasized practical education as well as the classics and literature
- 1893 The Agricultural College of Utah won a bronze medal for its exhibits on field research at the Columbian Exposition, Chicago's World Fair
- 1896 Cazier-Act passed to fund Agriculture Experiment Station to hold an annual Farmers' Institute in each of the new state's 27 counties--Extension Service began
- 1903 State authorized establishment of six branch arid farms throughout the state to perfect dry-farm agriculture
- 1903 President Kerr advocated awarding of graduate research degrees
- 1904 "Lecture Train" featured whistle-stop teaching in Utah and Idaho with exhibits from the Experiment Station
- 1904 The AC won a gold medal for its research exhibits at the World's fair in St. Louis
- 1906 Extension department established
- 1908 First scientific studies to measure the application of water to crops and vegetables at Greenville Farm in North Logan
- 1909 Ground-breaking research on spread of plant disease by insects
- 1910 *Dry Farming*, by John A. Widstoe, an agricultural classic, published
- 1911 First County Agent in Utah and in the West--Luther M. Winsor--placed in Vernal
- 1913 Branch agricultural college established at Cedar City Normal School
- 1914 First master's degree graduated
- 1920s Farmers and homemakers encampment-- "Tent City"-- on the Quad every summer

## A History of Tradition and Excellence (cont'd)

- 1923 First winter snow surveys used to predict irrigation water supplies
- 1924 National Summer School established, featuring distinguished scholars
- 1926 Department of Rural Sociology founded to study community life and rural home conditions
- 1929 Agricultural College of Utah renamed Utah State Agricultural College
- 1931 First new plant variety developed specifically for Utah farmers: "Relief" winter wheat
- 1934 Intermountain Herbarium established
- 1934 May Swenson, noted poet, graduated from USAC
- 1936 Forestry Camp established in Logan Canyon to serve as off-campus laboratory
- 1938 National History Field Expedition to conduct studies in southern Utah
- 1939 Utah State faculty advised Iran on water, soils, and crop management
- 1947 Research Foundation established; Graduate School founded
- 1949 Utah State faculty increased international involvement, administering President Truman's Point IV programs in Iran and participating in Greece, Turkey, and Lebanon
- 1950 First Ph.D. candidate graduated
- 1951 Branch agricultural college established at Snow College in Ephraim (until 1966)
- 1954 Utah Botanical Center established to demonstrate and practice sustainable principles to reduce impact on the land and its valuable resources
- 1955 Division of Research is created; headed by D. Wynne Thorne, also Director of the Agricultural Experiment Station
- 1957 The Utah State Agricultural College granted university status
- 1959 Electro-Dynamics Lab established

## A History of Tradition and Excellence (cont'd)

- 1960s Development of Trackmaster Snowcats and spin-off of Logan Manufacturing Company; commercialization of Wescor for soil sciences applications and medical devices for blood serum testing
- 1965 President Glen L. Taggart established office of Vice President for Research, filled by D. Wynne Thorne
- 1965 Utah Water Research Lab established--one of the largest hydraulic research laboratories of its kind in the U.S.
- 1967 Continuing Education Center established at Uintah Basin
- 1967 Ecology Center established; studies include brine shrimp, Antarctic ozone hole effect on plant DNA, mountain lion and Grizzly Bear populations and habitat
- 1967 Influential *Economics of Range Improvements* published
- 1969 Space Science Laboratory and Center for Research in Aeronomy established--now called The Center for Atmospheric and Space Sciences (CASS)
- 1970 Space Measurements Laboratory established
- 1972 Center for Persons with Disabilities established
- 1975 SKI\*HI Institute established to help children with sensory impairments
- 1976 USU begins work on NASA Get-Away Special (GAS) and becomes the #1 University with GAS payloads
- 1979 Rick Bass, noted nature writer, graduated from USU
- 1982 First student-generated space project from USU and the world orbited on the Space Shuttle
- 1982 Early Intervention Research Institute established in College of Education
- 1985 USU alumna Dr. Mary Cleave, a Shuttle crew member, carried on-board a USU Centennial Banner
- 1986 Research and Technology Park established
- 1986 Biotechnology Center established
- 1986 USU hosted its first annual Small Satellite Conference, which continues in 2003
- 1987 Utah State University ranked first on a per capita basis for its work in international development

## A History of Tradition and Excellence (cont'd)

- 1988 Space Dynamics Laboratory evolved from earlier aeronautical labs founded in 1959; more than 400 research payloads in a 40 year history; a world leader in sensor systems
- 1988 Western Dairy Center establishes a consortium of researchers and universities dedicated to understanding the complexities of milk and to developing new technologies and products from milk
- 1989 The Huntsman Environment Research Center established to engage in research in the key areas of recycling, degradability, improvement of air and water quality and conservation of trees
- 1990 U.S. Department of Defense listed USU as 6<sup>th</sup> largest university contractor; National Science Foundation ranks USU 61<sup>st</sup> among all universities for grants
- 1990 Engineering Education journal listed USU as #1 in the nation for research funds generated per faculty member
- 1990 *Great and Peculiar Beauty: A Utah Reader*, centennial anthology by editors Tom Lyon and Terry Tempest Williams
- 1991 Remote Sensing and GIS Laboratory established for application development and research
- 1992 Sorenson Vision commenced research into better ways to digitally store, receive and transmit high-resolution medical images, drawing on technology from Utah State University
- 1993 National Institutes of Health study on environmental and genetic determinants of dementia, especially Alzheimer's disease
- 1994 *Oxford History of the American West*, edited by Clyde Milner, II and Carol O'Connor, won the Western Heritage Award from the Cowboy Hall of Fame
- 1995 The National Center for Hearing Assessment and Management established at USU to oversee universal testing of newborns
- 1995 Social scientists Susan Dawson and Gary Madsen published groundbreaking work on the effects of uranium mining on Navajo families in the Four Corners
- 1995 Pathway to the Arts, an outdoor sculpture program, established

## A History of Tradition and Excellence (cont'd)

- 1996 Affiliated Research Center established with 8 other universities in the United States to perform state-of-the-art work in Remote Sensing, GIS and GPS areas
- 1997 Region VIII Head Start Disability Services Quality Improvement Center established
- 1997 National Institutes of Health grant to conduct statewide study of genetic and nutrition factors affecting hip fractures
- 1997 Applications of geographic information systems (GIS) in national resources management of farming
- 1998 The only cooperative program between the US Department of Defense and the Russian Ministry of defense (RAMOS) located in SDL at USU
- 1998 Emma Eccles Jones Early Childhood Center established
- 1999 Spider Lamb Syndrome on the road to elimination due to research by Noelle Cockett, a Fellow of the American Association for the Advancement of Science (awarded 2001)
- 1999 NASA named its first extension specialist--Phil Rasmussen--to help farmers and ranchers use satellite images to minimize environmental impacts while maximizing production
- 2000 USU's Space Dynamics Lab mapped global weather patterns, improving forecasts and tracking potentially deadly storms, through its new satellite-born sensor
- 2001 USU Research and Technology Park became "Innovation Campus"
- 2001 Jeanne Thomas and her students in the Folklore Program requested by the Library of Congress to collect and make sound recordings of Americans' accounts of and reactions to the terrorist attacks of September 11
- 2002 A team of Utah State University undergraduates unveiled their re-creation of the original Wright flyer made with modern materials.
- 2002 Utah State's new Biotechnology and Genomic Research Center was established, bolstering Utah State's worldwide reputation in agricultural biotechnology, natural populations, and microbial genomics.

# Utah State University Research Highlights - 2003

## cloned mule

A Utah State University-University of Idaho research team was first in the world to clone a member of the horse family, a mule, which was named "Idaho Gem." Since Idaho Gem's May 4 birth, the team has also cloned Utah Pioneer, born June 9, and Idaho Star, born on July 27. The project may provide new understanding of genetically-related problems for humans.

## innovation campus

Growth has been the theme of Utah State University's research park this year, with fourteen existing buildings and three more under construction. Innovation Campus' recently-completed master plan will guide growth over the next 40 years to bring it from its current 38 acres to over 150 acres by full build-out.

## governor's medal

This year, two Utah state professors were chosen to receive the Utah Governor's Medal for Science and Technology. Dr. J. Clair Batty, professor and head of the Department of Mechanical and Aerospace Engineering, and Dr. David S. Bowles, professor of Civil and Environmental Engineering and former director of the Utah Water Research Laboratory, received this honor in May.

## SARS research

Researchers at Utah State University's Institute for Antiviral Research are searching for drugs that will effectively control human viral infections, including severe acute respiratory syndrome (SARS).

## west nile virus research

The Utah Veterinary Diagnostic Laboratory conducted all veterinary-related testing for West Nile virus and detected the first Utah occurrences in both birds and horses.

## infant hearing research

The Teaching Learning Network is producing a documentary for National Public Television that features the National Center for Hearing Assessment and Management (NCHAM) and its work in screening newborns and infants for early identification of hearing loss.

# Utah State University Student Research Profile

## URCO grants






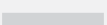
Each year, Utah State's Vice President for Research and each academic department provides grants for students to conduct their own research projects or creative works, called Undergraduate Research and Creative Opportunity (URCO) grants. The projects often create publishable results. Last year, 50 students conducted URCO research projects.

## national recognition

Every April, the USU Student Showcase highlights outstanding work done by students. Many of those students presented their work at national conferences in their fields. Eleven USU student projects were also exhibited at Washington D.C.'s Undergraduate Posters on the Hill--more than any other university.

## research courses

USU students get an education with a practical emphasis. Utah State offers 131 undergraduate research-related courses, including a new ethics course in responsible conduct of research in Spring 2003.

Senior thesis		25
Design		26
URCO		10
Research		25
Ind. Study		32
Methods		13

1,400 students conducted their own research projects to earn course credit. Additionally, Virtually all 2,502 graduate students attending USU in the past year actively conducted research projects of their own.

## research employment

Last year, federal government and private businesses provided funding to pay 1,100 students to conduct or assist with research projects at USU. Innovation Campus, Utah State's research park, also employs 900 students.

# Utah State University Facts of Interest

## general facts

Enrollment	23,000
Faculty	850
Semester Tuition (in-state)	\$1,307
Semester Tuition (out-of-state)	\$4,209

Utah State University was named one of "America's 100 Best College Buys" for two years in a row with the 4th lowest in-state tuition and 12th lowest out-of-state tuition in the nation.

### Financial Aid and Scholarships

Last year Utah State distributed more than \$56 million in scholarships and federal aid to nearly 60 percent of enrolled students.

## research facts

### Classification

Utah State University is classified as a Carnegie Foundation Doctoral Research University--Extensive, which is the highest possible. Only four percent of other higher education institutions share this top rank.

2003 Sponsored Program Awards      \$138.4 million

Utah State University is 12th in the nation in funding from the U.S. Department of Defense and receives 68 percent of research revenues from the federal government.

## revenues by source, FY 2002

Source	Amount	% Total
Tuition and Fees	\$46,803,490	12.4%
Contracts & Grants	\$135,461,092	35.8%
State Appropriations	\$129,039,443	34.1%
Private Gifts, Grants and Contracts	\$6,546,064	1.7%
Auxiliary Enterprises	\$32,245,390	8.5%
Other Sources	\$28,383,299	7.5%
<b>Total USU</b>	<b>\$378,478,778</b>	<b>100.00%</b>



# Think



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Utah State University  
1450 Old Main Hill  
Logan, Utah 84322-1450

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