Youth is disagreeable time, for it is neither possible then nor prudent to be productive in any sense whatsoever."  
— Friedrich Nietzsche (1844–1900)

Sorry, Herr Nietzsche, but I must respectfully disagree. It is possible and very prudent for young people to be productive in many ways, and many of them demonstrate it every day.

When you work on a university campus you are surrounded by young people. Although my job does not include teaching, I’ve been fortunate enough to interact with many students over the years. Yes, some of them seem more concerned about their next text message than their next test. And despite advice they’re given at student orientation, many still learn the hard way that energy drinks are no substitute for sleep when you’re trying to pay attention to a lecture, take a final or read a text book. Some are smart enough for college, but lack the common sense to wear a coat in northern Utah in January. I’ve also observed that freshmen look impossibly young every fall and that given the right tools and a good mentor, young people accomplish difficult things that reach far beyond their limited life experiences.

"Undergraduate researcher" may be a rare title at some universities, but not here. Take a look in labs, research farm plots and libraries and you’ll find students, even freshmen, doing research alongside faculty members who expect excellence. Utah Agricultural Experiment Station researchers are among the university’s honored undergraduate research mentors each year and their students pursue new knowledge in soil chemistry, economics, reproductive physiology, antiviral drug development — the list is as broad as the array of the world’s unanswered questions.

In talking with student researchers in many disciplines, I’ve found that although the work they do varies widely, some commonalities emerge. Most of them didn’t expect to be making discoveries until they had a couple of college degrees and professional titles following their name. But they are. Nearly all of the undergrads who moved into an established project and research group admit to being intimidated, and sometimes baffled, by discussions in meetings with their new colleagues. But things become clearer and soon they contribute ideas and, most importantly, questions. Most assumed they’d “pay their dues” by cleaning labs and running errands before they got to work on experiments or do field work. Instead they find they’re soon entrusted with helping to design and run experiments and are co-authoring papers to tell others what they’ve found.

Although it sounds trite, these fledgling researchers give me hope for the future nearly every day.

Many people lament the state of the nation’s young people and fear that their behavior will be the downfall of society. You don’t have to look far to be tempted to fall into that gloomy trap. But remember that while it’s simple to categorize whole groups of people based on the actions of a few individuals — even the actions of more than just a few individuals — it’s very rarely an accurate assessment. So the next time you ponder the state of the older teens and 20-somethings who will be tomorrow’s leaders, don’t be too quick to throw your hands in the air — unless you’re cheering.
MICROSCOPIC VIRUSES & BIG SCIENCE
Researchers are working to understand and treat virus-caused diseases, all while mentoring undergraduate students who have become colleagues in the lab.

THE WAR ON WEEDS
Effectively battling noxious weeds begins with knowing the enemy. Student technicians have spent years mapping weeds in the West so agencies can manage the land, and are learning a lot in the process.

NOT HARD TO DIGEST
Turning animal waste into fertilizer isn't new, but how about turning it into electricity or fuel for vehicles? Researchers are doing it and it's not alchemy, it's technology.

FORAGE KOCHIA AFTER RANGE FIRE
After the worst wildfire in Utah History, forage kochia in experiment station/USDA – Agricultural Research Service test plots was the first plant to re-emerge, hold soil in place and provide habitat for animals.
They may be tiny, even sub-microscopic, but viruses have very visible impacts on economies, countries, even entire continents. Of course, the big picture effects of viruses aren’t foremost in the thoughts of people who are personally suffering from yellow fever, AIDS, Ebola, SARS, avian influenza, a common cold or a host of other maladies. The range of symptoms associated with virus diseases and their big picture effects are, however, foremost in the thoughts of virologist John Morrey and his colleagues at USU’s Institute for Antiviral Research.

Scientists at the institute work with a wide array of viruses. Morrey, the institute’s director, focuses his work on hepatitis B, West Nile virus and uncovering the mechanisms of prion-caused maladies like chronic wasting disease and bovine spongiform encephalopathy, a.k.a. mad cow disease.

The term “virus” is Latin for toxin or poison and that is just what they inflict when they infect host cells which could be in plants, animals or bacteria. The immune response they trigger in animals, including humans, is sometimes potent enough to eliminate a virus and provide lasting protection against it. The resulting development of vaccines that immunize against diseases like smallpox and polio have been public health triumphs. But immunizations are not available against a great many dangerous virus-caused diseases, nor are effective drugs available to treat people and animals once they become infected.

While Morrey and others supported by the Utah Agricultural Experiment Station search for cures and vaccines, student researchers are learning right alongside them. In addition to the graduate students one would expect to find in such a lab, Morrey typically employs several undergraduate students who are treated as capable colleagues and who make significant contributions to the research.

“We do careful screening and students know what’s expected in the job,” Morrey said. “A lot of them are headed for medical school and want good references in addition to getting paid for their work. They take ownership of the projects they do and I don’t micromanage the lab. That’s the only way we can get all the things done that we want to achieve.”

And with viruses like West Nile and hepatitis B to be understood and conquered, there is plenty this team hopes to achieve.
WEST NILE VIRUS

Among the most exciting developments underway in Morrey’s lab is what appears to be the first treatment for West Nile virus (WNV) infection. In collaboration with Michael Diamond of Washington University in St. Louis, Morrey started working with a specific antibody in 2005, building on a the USU antiviral group’s previous five years of work on WNV with funding from the National Institutes of Health.

The first outbreak of WNV in the United States was reported in 1999 in New York. Morrey and other scientists took notice as the disease began to spread.

“I underestimated how rapidly it would spread,” Morrey said. “Our first experiments with West Nile were in 2000. The first paper we published in “Antiviral Research” was on our early cell culture research and is one of the most cited articles in the journal.”
We look at it now and it’s trivial relative to how much we’ve learned and the work we are doing now.”

The new treatment is set to move from the lab to clinical trials in people infected with WNV. The investigational drug, owned by Maryland-based MacroGenics, is a monoclonal antibody that Morrey originally doubted would be effective.

“I was getting tired of hearing about antibody treatment for West Nile virus because I didn’t think it would work,” Morrey said. “I thought we would prove the hypothesis wrong. Then, low and behold, I was wrong.”

That’s the way science works. Proving a hypothesis wrong simply means you learned something different from what you expected. Fortunately, what the team has learned so far appears very promising.

The antibody is specific for WNV and has been re-engineered to be compatible in humans. Work in Diamond’s lab found that the antibody attaches itself to the virus and prevents it from unlocking the genetic material it needs to grow and reproduce. The antibody is expected to prove useful in preventing infections. But among the most exciting results of the research is the finding that in animal models it is an effective treatment even after the virus reaches the brain. Morrey said the antibody is able to cross the blood-brain barrier to treat the virus — something many drugs are unable to do. His research team is able to detect the antibody in cerebral spinal fluid of treated hamsters, but there is a window of opportunity for successfully treating the virus. Morrey said six days post-infection in hamster models appears to be too long to wait for effective antibody treatment.

The researchers recently published a paper in the Proceedings of the National Academy of Sciences explaining how WNV travels through the central nervous system via long, slender nerve fibers called axons that project from nerve cells. In its early stages, WNV causes flu-like symptoms: fever, mild disorientation, head and body aches. Once the virus reaches the brain more serious neurological damage can result, causing paralysis, cognition problems and dementia.

“West Nile virus is largely not fatal in people, though it makes news when it is,” Morrey said. “The sad thing is that there are people who survive and have serious, lasting neurological consequences, including paralysis.”

Humans and horses get the virus from mosquitoes that have picked it up from infected birds. Another facet of research Morrey’s lab undertook was looking at the role that mosquito saliva may play in enhancing the disease-causing abilities of the virus. Working in collaboration with UAES entomologist Don Roberts, student researchers collected mosquito saliva for use in the lab. Morrey said there are examples of other viruses that become dramatically more virulent when mixed with mosquito saliva.

“For example, California encephalitis virus is non-lethal in adult mice,” Morrey said. “But when mixed with mosquito saliva it is one hundred percent lethal in adult mice. You could contract West Nile virus by some other route, say from blood of an infected horse that contacted a cut in your skin. We wondered whether a bite from an infected
mosquito is more virulent because of the saliva.”

After several months the lab stopped the mosquito saliva investigation because the saliva did not increase the incidence of paralysis caused by WNV.

Since its first appearance in the United States, the virus has caused more than 26,000 symptomatic cases of WNV infection. As of October 2007, the Centers for Disease Control counted 2,511 cases of reported WNV infection nationwide and 64 fatalities for the year. Among the reported cases, 766 patients developed encephalitis or meningitis, 1,684 had fevers and 61 showed other clinical symptoms. Morrey predicts that many people would test positive for WNV infection, but because they did not have reportable symptoms they didn’t know they had the virus. People over age 50 are considered at higher risk, as are small children and people with depressed immune systems. Interestingly, Morrey and his colleagues note that while people in higher risk groups are more susceptible to encephalitis and meningitis, people of every age and immune status are at risk for developing paralysis. The team is studying the electrical properties of cells and tissues (electrophysiology) to measure the health of nerves in WNV-infected animals. The investigation is aimed at learning more about the neurological damage that lingers even after the virus is eliminated by the immune system, a result that is also seen in human patients.

“Very small numbers of infected people develop neurological problems or die,” Morrey said. “But

WEST NILE VIRUS
Morrey said it’s very exciting to see the antibody treatment move toward clinical trials, paving the way for it to become available for people affected by the virus.

“This is really nice because science typically works at such a snail’s pace that to have something prove to be useful in just a few years is very satisfying,” Morrey said. “Going to clinical trial is a big step in drug discovery and it’s very exciting.”

HEPATITIS B

Although his goal is a career in medicine, performing surgery certainly wasn’t something Josh Durrant expected to do as an undergraduate. Doing liver biopsies and keeping his lab mouse patients alive were not skills he planned to acquire. But after doing more than 1,000 of the procedures and performing other tasks in the lab, he has learned lessons that simply can’t be adequately taught by reading a text book or hearing a lecture. Among them are that “science is really fun” and he is capable of doing things wasn’t sure he could do.

“Even when you do the same things over and over again, there is no typical day in the lab,” Durrant said. “I started working with Dr. Morrey as a sophomore and I’ve been involved in some animal work with the prion research, West Nile virus and hepatitis B. I look back now and can’t believe how much I’ve learned.”

The team in Morrey’s lab, with support from the National Institutes of Health, evaluates about ten drugs each year for their ability to reduce production of hepatitis B virus in transgenic mice. The drugs are not developed in the lab, but are primarily new drugs that require testing before moving forward or being abandoned in the long process of drug development.

Some people experience acute (self-limiting) hepatitis B infection with its accompanying nausea, vomiting, body aches, dark urine and jaundice, but are able to clear the virus in a few weeks or months. However, the Centers for Disease Control (CDC) estimates that 1.25 million Americans are chronically infected with hepatitis B, and the virus has caused epidemics in parts of Africa and Asia. Chronic hepatitis B infection interferes with liver function and can inflame the liver, leading to cirrhosis and a significant increase in the incidence of liver cancer. The CDC estimates that death from liver disease occurs in 15-25 percent of people with chronic hepatitis B infection.

“There is a vaccine which has reduced the incidence of infection,” Morrey said. “But the disease is not gone and for those who have it is a life-threatening, chronic disease. If left unchecked it is fatal.”

The drugs are tested in transgenic mice and evaluated for their ability to reduce virus production. They are not tested for relieving disease symptoms because hepatitis B infects members of the family Hominoidea, which includes humans, chimpanzees and gorillas — not mice. The mice used to establish the USU colony were originally produced at the Scripps Research Institute and engineered so that the hepatitis B virus gene is contained in the mouse gene and the virus’s genetic material is inherited by the animals’ offspring. Researchers measure the virus load in the animals because the mice are not “infected” and do not exhibit symptoms. Morrey explained.

“It’s not an infectious process,” he said. “The virus is just part of the mouse genetics. Students are involved in screening mice to see which are suitable for use in the hepatitis B experiments to test existing, usually new, drugs. We use gas anesthesia, remove a very small portion of the mouse liver, sew them up, give them antibiotics to fight post-op infection and keep them alive. Students also extract viral
DNA and viral RNA from the liver.”

It’s such an unusual procedure that the researchers were unable to find the right tools ready-made to do the job. Instead, they designed their own. The team had surgical instruments coated with Teflon and then heat them during surgery so that as incisions are made and liver tissue is removed the wounds are cauterized to minimize bleeding.

Durrant, who is currently in dental school at Case-Western University, credits his work in the lab with giving him valuable experience he will use in dealing with human patients.

“The surgical procedure on the mice is relatively simple surgery,” Durrant said. “But doing it taught me to treat every mouse on a case-by-case basis. After repeating the same procedure so many times there is a tendency to think of it as routine. You know right where to make the incision, what you’re going to see and what will happen. Then sometimes, what you expect does not happen. I’ve learned that nothing is routine because you are working with different individuals.”

Because he was in the lab with other undergraduate students who were doing experiments and sharing ideas in weekly lab meetings with Morrey and his graduate students, Durrant said he didn’t realize how unusual his experience was until he was in group interviews for dental school.

“It became clear during the group interviews that getting to do this level of work as an undergraduate is very unusual,” Durrant said. “John (Morrey) doesn’t just feed you information, but expects you to be curious and he’s willing to explain and help you find answers. One meeting each week is open to anyone in the lab and they really discuss the science going on in the lab. It’s easy to get stuck in the procedures and not see the big picture of the science, but in these meetings people bring up new hypothesis and discuss the data. My work here also gave me an edge when interviewers asked about evidence of our manual dexterity, which is important in dentistry. Other candidates talked about playing piano or woodworking. I told them I had done surgery on over 1,000 mice, performed liver biopsies and kept the animals alive. That prompted a lot of questions about our work and turned out to be pretty impressive and exciting to talk about.”

Knowing that his students get experiences like that simply reinforces Morrey’s commitment to giving undergraduates opportunities for meaningful work in his lab.

“I feel an extra dimension of purpose in my work when I know these students can go and talk intelligently about what they are doing,” he said. “It helps them achieve their goals and they are going out to do more good in the world even though our lab is a tiny speck in the giant world of drug development.”

But, as anyone who studies viruses knows, even a tiny speck can make a huge difference.

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The concept is simple: if you’re going to do battle you need to identify the enemy and know its location. When the enemy is invasive weeds and the potential battlefield is thousands of acres of rugged and some not-so-rugged public land, completing the task is far from simple.

Utah Agricultural Experiment Station researcher Steve Dewey knows very well that doing this sort of work over vast areas requires a team effort. With support from USDA, Dewey has assembled teams of student field technicians who spend their summers creating maps of weeds that are gaining footholds or that have aggressively invaded plant communities on public land in many national parks and monuments and busy U.S. Forest Service campgrounds.

Members of the weed mapping team sometimes work in the same area, but often establish a common base camp and work solo throughout the day as they hike, check maps, note coordinates on handheld global positioning system (GPS) units, visually scour each transect for specific weeds and record which weeds are present and how abundant they are. This on-the-ground work is very labor intensive so mapping is done in targeted areas that are suspected of...
Clockwise from top left:
Steve Dewey, Kim Andersen,
Michelle Oldham, Anna Schmidt.
being infested by invasive plants or in areas that are likely to become infested.

It can be hot, lonely, tedious work, but team members know it's important because invasive, weedy plants take a tremendous toll in dollars and effort required to fight them and in damage to native plant communities, waterways and livestock. It's estimated that economic losses from weeds exceed $20 billion in the U.S. annually. And while the weed mapping team concentrates on public lands, it's important to remember that weeds don't recognize fences or property lines so a weed problem in one location can quickly become a problem on adjacent land.

"Mapping is important because it helps land managers make decisions about where to concentrate their weed management efforts," Dewey said. "And knowing which species are present and exactly where they are is crucial."

Kim Andersen, a mapping team veteran, explained that weed identification is important because while one area may appear to be widely infested, another area may require more immediate attention because the weeds there are more aggressive or pose a greater threat.

Some people think of a weed as a plant that's just growing in the wrong place, but weeds are more than just errant flora. Weeds invade and crowd out valuable native plants that provide food and cover for livestock and wildlife. Weeds — cheatgrass a.k.a. downy brome in particular — add fuel to dangerous wildfires and can shorten the intervals between fires, making it difficult for beneficial plant communities to recover. Weeds also decrease yields on crop land, use large amounts of valuable water and can poison surrounding plants.

One summer several campgrounds in western states were mapped. It was a different environment and experience for technicians who are more accustomed to the solitude of working in the seldom traveled parts of vast national parks. Again and again the students introduced themselves, and several species of weeds, to many curious campers.

"You get some strange looks from people when you walk into their campsite, but our shirts help identify us and it was a really good chance to educate people about the problem and about some of the specific weeds we are looking for," said Michelle Oldham.

In addition to learning a lot about plant taxonomy, GPS tools and how to turn data into meaningful reports for land managers, students on the weed mapping team have learned lessons about the human side of natural resource management and the need for diplomacy. In one location some members of the team came upon a group of land managers and enthusiastic volunteers who had gathered to do battle with thistle that had infested a hillside. However, what the eager group thought was yellow starthistle,
There are weeds, the odd dandelion or patch of crabgrass that appear in the landscape, and then there are noxious weeds — invasive, non-native plants that threaten crop yields and animal health, alter wildlife habitat and crowd out beneficial native species.

The Utah Commissioner of Agriculture determines which weeds are designated "noxious" and are subject to the Utah Noxious Weed Act which requires landowners to take actions to control them. There are 18 species designated noxious across the state (although Bermuda grass is exempt in Washington County) and many more that carry the distinction in specific counties. What follows is Utah Agricultural Experiment Station researcher and USU Extension weed specialist Steve Dewey's own selection of Utah's top 10 most unwanted weeds.

**Russian Knapweed (Centaurea repens)**

While Russian knapweed may grow two or three feet tall its roots may run eight feet deep. It infests rangeland, field edges, pasture, roadsides and other disturbed soils. Like other members of the knapweed family, this weed releases chemicals into the soil that inhibit growth of other plants. When eaten by horses, Russian knapweed causes irreversible brain lesions associated with a fatal disease commonly called "chewing disease." The chemicals that cause the disease can accumulate in horses over a period of just a few months and can cause significant damage before owners realize their animals are sick.

**Control:** Limited biocontrol is available. Select herbicides offer good to excellent control when applied between pre-bloom to killing frost.

**Yellow Starthistle (Centaurea solstitialis)**

Another weed that can cause deadly "chewing disease" in horses is yellow starthistle. This two to three foot tall winter annual grows well on dry sites in rangeland, roadsides and waste areas.

**Control:** Several biocontrol agents have been tested but their availability is limited. Select herbicides offer fair to good control when applied between the rosette and bloom stages. Tillage is also effective.

**Field Bindweed (Convolvulus arvensis)**

Often called wild morning glory, field bindweed reproduces from seed and rootstock. It's stems lay on the ground, or climb other vegetation and structures, and can grow up to six feet long. This tenacious weed can sink its roots more than 10 feet deep and seeds may remain viable in the soil for up to 50 years.

**Control:** Biocontrol is not available. Several herbicides provide good control when applied from late spring to killing frost.

**Hoary Cress (Cardaria draba)**

Commonly found on disturbed sites, field edges and excavations, hoary cress also invades grain fields, cultivated fields and grows well on saline soils. Hoary cress is a perennial with finely toothed leaves on one to two foot stems and reproduces by root segments and seed.

**Control:** Research to determine an effective biocontrol agent is still in its early stages. Some herbicides provide fair to good control when applied to the flowers just before they bloom. Digging also provides good control.

**Dyer's Woad (Isatis tinctoria)**

In many parts of Utah, spring means seeing field edges, roadsides, pastures and even entire hillsides blanketed with the bright yellow blossoms of dyer's woad. The plants commonly grow between one and four feet in height and it's thick taproot may reach five feet deep.

**Control:** A biocontrol rust fungus is naturally widespread and has been the subject of UAES research. Leaves of rust infected plants have puckered, yellowish leaves with dark spots on the undersides. Herbicides offer good to excellent control when applied to rosettes in spring or fall and during pre-bloom.

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**Continued on Page 7**
designated as noxious in Utah, was another type of thistle that is not considered noxious. The USU weed warriors quickly decided it was more important to support enthusiastic care for public land and weed eradication than to tell the group they had the wrong thistle. They took a break from mapping, joined the volunteers and dug thistle.

But the team has mapped its share of weedy species. During the summers of 2002-2005 the weed mapping team and National Park Service collaboratively inventoried and mapped more than 40 species of non-native, invasive weeds on approximately 134,700 acres in targeted sections of 12 national parks and monuments in the Northern Colorado Plateau. They found invasive weeds infesting 5,331 acres of the areas they covered. Saltcedar, also commonly called tamarisk, was the most prevalent species inventoried. It was found in all but one of the parks and made up 58.1 percent of the total infested acreage. The most abundant herbaceous weed was perennial pepperweed which occupied 296.9 acres but was found in only four parks.

The team concluded that although the presence of weeds in the national parks is cause for considerable concern it was encouraging that more than 96% of the total area inventoried was not home to the targeted weed species. They also noted that prevention and rapid response are important weapons in the battle against weeds because many species spread so rapidly. Final reports and additional information about the national parks and monuments inventories can be found online at www.nature.nps.gov/im/units/ncpn/Reports.cfm.

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All weed photos: Steve Dewey
Leafy Spurge
(Euphorbia esula)

Not only is leafy spurge a very aggressive invader of pastures, rangeland, stream banks and waste areas it is toxic to cattle and may cause their death. The plants reproduce by seed or rootstock. Each plant has an extensive root system that can spread up to 20 feet and penetrate 14 feet into the soil. Leafy spurge seeds are contained in small capsules that, once dry, can eject seeds up to 15 feet from the parent plant.

Control: Extensive biocontrol is fair to excellent, depending on location and conditions. Herbicides are applied from spring to killing frost and provide fair to good control, especially in combination with biocontrol methods.

Cheatgrass
(Bromus tectorum)

This weedy, annual grass is not classified as a noxious weed in Utah, but it is found in every county and its invasive nature and the tremendous fire danger it poses put it on Dewey’s list of weeds to fight. Plants range from 2 inches to 2 feet tall and reproduce from seeds which germinate in the fall or early spring. Cheatgrass, also known as downy brome or June grass, is very aggressive and quickly invades heavily grazed rangeland, roadsides, waste places, burned areas and other disturbed sites. When it dries just in time for fire season it becomes a dangerous, explosive fuel for fires that endanger life, property and beneficial perennial plants and cost taxpayers millions of dollars to battle.

Control: Aim for replacing cheatgrass with a perennial plant cover which means managing sites in ways that give desired plants the advantage over cheatgrass.

Canada Thistle
(Cirsium arvense)

Also known as field thistle, Canada thistle is the most widespread of the thistles and is documented throughout the state, with the sole exception of Washington County. A perennial that can reach four feet in height, the plants reproduce by seeds and rootstock and adapt to a wide variety of habitats.

Control: Several biocontrol agents offer fair control and herbicides can offer good control when applied to actively growing plants from spring to fall. As with most creeping perennials, digging or tillage is not generally effective.

Scotch Thistle
(Onopordum acanthium)

Documented in all but Daggett and Wayne counties, Scotch thistle is a highly visible weed that commonly grows between three and eight feet tall, but can reach as high as 12 feet. The large spiny leaves can grow up to two feet long. Scotch thistle grows well in waste areas, pastures, on rangeland and along canals and streambanks.

Saltcedar
(Tamarix ramosissima)

Although Uintah County is the only county in the state that has designated saltcedar a noxious weed, it’s rapid spread and ability to damage land and waterways earns it a spot on the list. An inventory of weeds in 12 national parks of the Colorado Plateau that was done between 2002 and 2005 found 11 parks infested with saltcedar and revealed that it was present on more than 3,000 acres included in the study — well ahead of the acreage dominated by the next most prevalent plant on the list, Russian olive, on 392 acres. Also commonly known as tamarisk, tamarik or tamarix, saltcedar grows between five and 20 feet tall. Its feathery, pale pink blooms and rapid growth habit made it a popular ornamental plant, but saltcedar infests lake and stream banks, pastures and rangeland where it becomes a formidable water thief. Large plants can transpire 200 gallons of water per plant per day, and have the potential to completely dry up ponds and streams.

Control: Biocontrol methods are undergoing testing but select herbicides offer excellent control when applied from late summer to early fall.

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Most of us who enjoy milk, cheese, pork chops, bacon or the myriad other products of animal agriculture rarely give a thought to the animal waste that inevitably accompanies their production. Experiment Station researcher Conly Hansen, on the other hand, has devoted years to thinking about animal waste and devising ways to handle it so that farmers and the environment benefit. At the same time, he's working to find ways of generating energy that don't rely on oil or coal.

It's no small challenge. A well-fed dairy cow produces about 120 pounds of manure every day, waste that can raise nutrient levels in ground and surface water and that carries with it the unmistakable odor that becomes a problem when farms become hemmed in by residential development.

The results of Hansen's work is an induced blanket reactor (IBR) which anaerobically digests organic waste, resulting in methane that can be used to fuel vehicles or generate electricity, clarified and remarkably odorless liquid that can be used for irrigation, and dry solids that are an excellent soil amendment or animal bedding.

Andigen, a commercial spin-off from Hansen's research, has IBRs operating on farms in Utah and Idaho and is building others in California, Minnesota, Montana and Canada. Andigen isn't the only company turning animal waste to energy and useful products, but Hansen and his team have managed to cut the processing time to below the industry standard, and uses tanks scaled to handle waste from 250 cows while most others are built to handle waste from 1,000 or more.
Top: Carl Hansen, John Milligan and Conly Hansen check conditions inside anaerobic digestion tanks at Wadeland Dairy on a monitor connected to the system’s controller. Bottom left to right: Waste is pumped into a holding tank next to the building that houses the digester. After treatment, liquid is pumped into a tank and ready for irrigation on the farm. Waste and water are mixed before treatment. Monitors provide data on conditions inside the digester tanks. Tanks used on the biogas-fueled truck.
"We want this to be doable for smaller farms," Hansen said. "People can put in one, four or eighty tanks depending on the size of their operation."

There is still research to do, adjustments to make in the system and the hope that the computer-operated controller for the system will become less expensive, but the technology is promising and becoming even more attractive as energy use and the impact of waste on the environment gain increasing political, social and commercial attention.

What’s the Process

With Hansen as tour guide, a visit to the Wadcland Dairy in Weber County, Utah provides a lesson in the basics of how an IRB operates and how waste is changed to more useful, nearly odorless products.

The facility was built in 2004 as a research project partnering the Utah Agricultural Experiment Station, Utah State University, the U.S. Department of Energy and the U.S. Department of Agriculture.

About two feet of water per second intermittently flush waste from the Wade’s herd of Jerseys down a flume and into a pit. From there a pump moves it through pipes and into one of three tanks housed just a few yards away from the cows. The round tanks loom overhead (32 feet tall for the 30,000 gallon tanks and 20 feet for the 20,000 gallon tank) and are housed in a small building that helps regulate the temperature during cold northern Utah winters.

Hansen explained that IBR digesters in locations with more constant and moderate temperatures don’t need to be sheltered in buildings. There’s nothing flashy about the appearance of the digester, just tanks, the hum of pumps and a colorful illustration of the system on a computer screen that allows an operator to monitor temperatures, pH, water content and gas production inside the tanks where the bacteria-driven real action is.

A device introduces various microorganisms that go to work digesting waste at various levels in the tanks. Hansen said anaerobic digestion is generally quite complicated and at least three completely different organisms make the system work. The first, hydrolytic bacteria, break down large proteins. Secondly, acetogens do work the first bacteria could not and make acetic acid, butyric acid and "all kinds of other nasty stuff" Hansen said. Finally, methanogens, single cell microorganisms that are similar to bacteria, do the work that is left digesting things the bacteria cannot and producing biogas which is primarily methane. The team has also experimented with adding other ingredients to the mix — cheese processing and meat packing waste, for example — and found the bacteria loved the higher sugar, fat and protein content.

"Different strains of bacteria emerge and natural selection takes over," Hansen said. "We control the environment in the tanks as best we can, but it’s still a jungle in there. Our goal is to provide the microorganisms with the best environment for their work. I’m sure I’d give at least a million dollars to find
What's left after the digester has done its work are solids that are good for composting, biogas that can be used to generate electricity or fuel vehicles, heat that is captured and used in the system and nearly clear liquid that can be used for irrigation. At the Wadeland Dairy, Hansen scooped a handful of the processed solids from a pile outside the digester shed and offered a whiff to visitors. It had a faint, earthy smell, but no trace of anything like manure. The lack of objectionable odors was even more striking when visitors realized they were downwind on a breezy day and standing just 15 feet away from the large open pool that holds the liquid from the waste digestion process. You wouldn't want to take a swim in it, but it was clarified and had no odor.

"When they spray it on fields for irrigation it doesn't smell," Hansen said. "That's important because we want to help farmers stay in business, and as farms become more crowded by commercial and residential development farm odors become a problem. And capturing and using methane is going to become even more important as regulations on greenhouse gas emissions get tighter."

After processing though, excessive nutrients in the waste water remain a challenge. Some soils are able to use the nutrients — primarily nitrogen and phosphorous — to produce healthy crops. But some other soils are already "stuffed up" Hansen explained, using a euphemism he heard from researchers in Australia, and are unable to absorb more nutrients. That situation can adversely affect ground and surface water quality.

Methane captured by the system is used, in most cases, to generate electricity that is used on the farm and can be sold back onto the local power grid. Selling power does not always go smoothly though as utility companies grapple with how to accommodate farm-generated power and the going rates for electricity vary widely from state to state and country to country.

"People think of electricity first because it seem easy on paper and they are familiar with the idea of generators and using electricity," Hansen said. "But what we're handling here is really natural gas and
are solids that are good for composting, or fuel vehicles, heat that is captured and can be used for irrigation.

people need to think of using it as gas.”

For example, a truck driven by Andigen employees is fueled with methane captured by IRBs and Hansen envisions other vehicles doing the same. The truck was originally engineered to run on natural gas. The researchers began mixing various amounts of methane with natural gas in the truck’s tank, and eventually moved away from using any purchased natural gas. And now, while exhaust from vehicles that run on recycled cooking oil smell vaguely like the foods that were once cooked in the oil — think French fries and Chinese food — the Andigen truck’s exhaust does not smell like farm waste.

Synergy for Sustainability

In the early stages of his IBR research, Hansen sought ways to work more closely with other researchers because of the chemical, biological and engineering complexities of the process. In the past year, he became a founding member of the new Utah State University Biofuels Initiative, a state-funded project that brought together a core group of researchers with related expertise to work toward developing commercially viable biofuel products and technologies.

“I'm a farm boy who became an engineer and I got in this to help farmers,” Hansen said. “I know I don’t have all the answers, and in academia we tend to work on problems by ourselves and look to the literature. Everyone is so busy that the person who could have a great idea or an answer to your question may be right on campus. In the commercial realm nobody wants to talk because equipment and methods are proprietary. The opportunity for synergy with other researchers is critical to figuring out these kinds of problems.”

Though he may not have all the answers, Hansen is certain of one thing: Some drastic changes must be made in the ways that people, especially Americans, create and use all kinds of energy. Otherwise, he said, we’re headed for disaster. Hansen said it’s never been more important to discover alternatives to fossil fuels and he intends to help farmers prosper while being part of the solution.

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Agriculture Teaching and Research Center Dedicated

Utah State University's newest teaching and research facility is a state-of-the-art and "state-of-the-science" building for teaching and animal research. But, as many speakers at the building's May 8 dedication pointed out, it is also a symbol of the state and the university's agricultural heritage and commitment to agriculture's future.

State Senator Lyle Hillyard told guests at the dedication that former USU President Kermit Hall first brought up the idea of creating a new agricultural facility. Hillyard said he immediately recognized that it was a critical time for the state to make a strong, clear commitment to agriculture or risk having USU students fall behind.

"They may create something here that impacts agriculture around the world." Hillyard said in describing how research and teaching at USU reach well beyond Cache Valley and the state to affect agriculture internationally.

Stressing the importance of the new facility to the state, Utah Commissioner of Agriculture and Food Leonard Blackham said, "Utah agriculture is animal agriculture. Eighty percent of Utah agriculture is livestock."

Blackham said agriculture's success depends largely on science, improved management practices, communication and work ethic, and that these four are directly tied to USU through its teaching, research and extension missions.

USU President Stan Albrecht thanked legislators for their strong support of the project, particularly Senators Peter Knudson and Hillyard. While buildings are not named for sitting legislators, Albrecht said university administrators felt strongly that Hillyard should be honored for his service to USU in securing the $10 million of state funds to construct the new building. In that spirit, Albrecht unveiled the sign for the new building: The Matthew Hillyard Animal, Teaching and Research Center.

Matthew is the 33-year-old son of Senator Hillyard and his wife Alice. Matthew, who has Down syndrome, moved into place to help cut the ribbon and officially open the building to the applause of guests including several of his siblings and their family's. Senator Hillyard said he predicts that Matt will ask to stop by occasionally to see whether there is chocolate milk and Aggie Ice Cream at his building.

Noelle Cockett, Vice President
for USU Extension and Agriculture, said the building, the complex of existing facilities and those scheduled for future development are "a celebration of our students, our research and the extension work we do throughout the state." She added that the location, on the east side of Highway 89-91 in Wellsville is a beautiful setting and visible celebration of agriculture's legacy in Utah.

Cockett also announced the naming of one of the building's main classrooms after Mark C. Healy, former head of USU's Department of Animal, Dairy and Veterinary Science. Cockett said Healy, who died of pancreatic cancer in December 2007, was a driver of the project and inspired everyone involved in its planning and construction.

The open design and large windows of the Matthew Hillyard Animal, Teaching and Research Center's lobby provide wide views of Cache Valley's mountains and provide abundant natural light. The building was designed by Jacoby Architects and built by Jacobson Construction. One wing of the building includes a classroom, offices and several animal physiology and reproduction labs. There is also a suite of veterinary medicine facilities including a lab, surgery, recovery and animal holding areas. The building's north wing houses another classroom, USDA-inspected meat lab, refrigeration rooms and office space. In addition to the sizable legislative appropriation, Cockett said the project was a team effort, bringing together funding from the Utah Agricultural Experiment Station, Department of Animal, Dairy and Veterinary Sciences, USU Extension and individual animal science researchers.

**Economist Honored by FFA**

Over the course of his career in agricultural economics, UAES researcher Bruce Godfrey has garnered a number of awards and now adds the top honor bestowed by the National Future Farmers of America to the list.

Godfrey received the Honorary American FFA Degree at the organization's national convention. The award recognizes outstanding service to agriculture and agricultural education.

Godfrey's career is a reflection of the mission of land grant universities, combining teaching, research and service. He has been honored as an outstanding mentor for student researchers at Utah State University and carried on his own research programs. He has taught a variety of classes encompassing agricultural and natural resource economics, including agricultural marketing and policy, natural resource and environmental economics, agribusiness finance and price analysis. Godfrey was named 2006 Professor of the Year for USU's College of Agriculture, and his service on University Extension's Public Lands & Grazing Team earned him the Vice-President's Award for Excellence.

He is a Distinguished Scholar of the Western Agricultural Economics Association and a long-time member and leader in the American Agricultural Economics Association.
Dairy Researcher Earns International Honor

Most scientists work in relative obscurity with occasional recognition from their peers and infrequent notice from the public. Donald McMahon, a UAES researcher and professor of food science, received some much-appreciated peer recognition in the form of the International Dairy Foods Association Research Award in Dairy Foods Processing.

"Having my research recognized by other dairy scientists was an honor," McMahon said. "Utah State has a long tradition of being a leader in dairy foods research and it’s great to be a part of that tradition and making a difference in the advancement of the dairy industry."

McMahon directs a lab that is far from obscure, even to people who might typically shy away from research — the Gary H. Richardson Dairy Products Laboratory which is the source of famous Aggie Ice Cream and True Blue Aggie cheeses. He has published more than 65 papers...

TEACHING GARDEN DEDICATED AT UTAH BOTANICAL CENTER

The H. Paul and Mary Jane Rasmussen Teaching Garden has become a much-loved and inviting spot at the Utah Botanical Center since its opening. It is also a beautiful and growing remembrance of Mary Jane Rasmussen who died of pancreatic cancer in October 2007, just few weeks after spending a beautiful morning at the garden surrounded by family and friends who attended the dedication.

Adjacent to the UBC greenhouse, the garden is open to the public and used extensively by the more than 150 students working toward degrees in Utah State University's off-campus horticulture program. The garden is named in honor of the Rasmussen's ongoing support of the UBC and its mission to conduct research and to demonstrate wise use and preservation of plant and water resources.

As director of the Utah Agricultural Experiment Station, Paul Rasmussen has been involved with the UBC since its inception and worked on the original land acquisition. USU President Stan Albrecht told guests at the dedication that Rasmussen's involvement with the UBC has gone beyond his professional stewardship.

"Paul and Mary Jane have put their hearts and souls into this place," Albrecht said. "Their dedication goes beyond leadership. They have committed their energy and personal resources to supporting the mission of the botanical center and especially to this teaching garden."

The garden, designed by UBC Gardens Manager Anne Spranger, is a series of planting "islands" bordered by gravel pathways and framed on two ends by arbors. Dave Anderson, UBC associate director, said the islands were designed to be viewed from all sides and the plants they feature will be changed occasionally to fit changing needs. In addition to the garden's more changeable elements, a collection of iris representing Dykes' annual award winners since 1947 and daylilies moved from the university's former botanical garden site in Farmington.

Paul Rasmussen said the thing that has driven his and his wife's support of the UBC is their belief in the importance and value of education. In addition to being home to the horticulture degree program, the UBC is the site of many Extension gardening classes and more than 4,000 children visited the center last year on field trips tied to the state's science curriculum.

"Even early in our married life we believed that education would be very important for our children," he said. "After they completed their educations we felt it was important for us to be able to help others."

"...We have also been supportive of the botanical center because it is now a green space and urban fishery in the midst of development has been very rapid since the property was acquired."

Nearly a year after its opening, the garden is thriving, including flowering vines that climb trellises at either end of the garden, planted by the Rasmussen's children and grandchildren.

Photo: Elizabeth Lord
on dairy science topics and has mentored 22 graduate students and seven doctoral students, many of whom have assumed leadership roles at major dairy processing companies. He has also embodied the university's land-grant mission, using research advances in teaching and supporting the product lines of small, local artisan cheese companies.

McMahon's research has addressed numerous questions related to the effects of processing on milk protein structure and function. That research, and his work on cheese chemistry, have significantly enhanced the dairy industry's ability to manufacture higher quality cheese products.

The American Dairy Science Association, which presented the award, is an international organization of educators, scientists and industrialists who are committed to providing scientific and technical support to sustain and grow the global dairy industry.

ENVIRONMENTAL STEWARDSHIP AWARD RECIPIENTS HONORED

Two outstanding organizations share more than a deep commitment to Utah's resources and future, they are also both recipients of the Utah Botanical Center Environmental Stewardship Award.

Envision Utah was the inaugural award winner in 2006, and this year The Nature Conservancy in Utah was honored with the award. Criteria for the award defines stewardship as, "...more than conservation, education and environmental science, it is also a moral and spiritual obligation to the present day community and to future generations."

The award is tied to the Utah Botanical Center's (UBC) mission, which centers on studying, teaching and demonstrating responsible use of natural resources. UBC Associate Director Dave Anderson said honoring groups and individuals that are committed to wise stewardship acknowledges the fact that caring for the environment requires a wide range of activities and partnerships. Another of the award's goals is raising awareness among citizens about Utah's environmental challenges and successes.

"A million more people are expected to live along the Wasatch Front (chain of cities and towns along the Wasatch Mountain Range in north/central Utah) by the year 2020. We will all share the same air, land and water. We must act now if we are to be prepared for the challenges and benefits that accompany growth and enjoy our quality of life," Utah State University President Stan. L. Albrecht said in presenting the award to Envision Utah.

The organization brings together local residents and key decision-makers to create plans that guide development of Utah communities while preserving critical lands, promoting water conservation and clean air, effective transportation systems and housing options for people of all incomes. In accepting the 2006 award, Envision Utah Chairman Jerry Stevenson said, "Envision Utah is not a political organization. It is a quality of life organization. What we do is teach all of us how to play well together."

Speaking at the 2007 gathering to honor The Nature Conservancy, Envision Utah Executive Director Alan Matheson said a new study of what Utahns value highlights a recurring theme of love for Utah's beauty that spans all political and religious differences. He noted The Nature Conservancy's work in Utah over the past 20 years has preserved nearly 880,000 acres of public and private land.

"The Nature Conservancy emphasizes people, respecting their property rights and honoring their traditions and livelihoods," Matheson said. "They seek collaboration, at times even with those who would rather fight. They refuse to get bogged down in dogma and, instead, simply solve problems. "The Nature Conservancy emphasizes people, respecting their property rights and honoring their traditions and livelihoods," he said. "They seek collaboration, at times even with those who would rather fight. They refuse to get bogged down in dogma and, instead, simply solve problems. They rely on solid science to set their agenda. And, most importantly, they are effective."

In presenting the award — a crystal obelisk generously donated by O.C. Tanner — Albrecht pointed out that the award itself is a reminder that issues of environmental stewardship are viewed differently from various angles and can come together beautifully with shared goals and effort.

Dave Livermore, The Nature Conservancy's state director, added, "Blending built civilizations and the natural world is a messy process, but we believe it is not enough to sound the alarm and curse the darkness. It's better to light a candle."