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### The Doctors of High-Tech Medical Research

Dr. Joseph Andrade

It's nine o'clock on a Saturday morning and the halls of the Merrill Engineering Building on the University of Utah campus are nearly deserted. In a few hours the halls will be bustling with activity. But for now, one of the few lights on is in room 2480 in the northeast corner of the building where the office of Dr. Joseph Andrade, chairman of the Department of Bioengineering, is located.

It takes a lot of time to head a department that is recognized as having one of the top five programs in bioengineering research in the United States. For Andrade this translates to long days and often weekend work. The department consists of 13 areas, each performing research which is impacting the medical field.

One of the most high-profile divisions in the department is that of Artificial Organs and Medical Implants which is where research on the artificial heart and artificial blood vessels is done. The Biomechanics Division of the department works on projects such as the artificial arm. And a new thrust for the department is that of developing medical instruments and methods that Andrade says will help to decrease the cost of health care.

From his second floor office, Andrade acts as a coordinator for these research projects. During the past 15 years the university's bioengineering program has developed and grown and gained a reputation as being one of the best in the nation. Andrade credits the development of bioengineering activity at the university and in the region to Dr. Willem J. Kolff, father of the artificial heart, who was recruited by the University of Utah in 1967 from Cleveland.

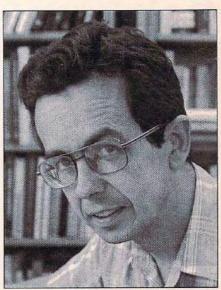
Andrade's own expertise is in the interaction between certain materials and blood, and he is currently working on developing a device that will measure blood proteins in a simple, easy, and continuous manner. With such a device, many blood tests could be done in a doctor's office or in the operating room without having to be sent to a lab.

The programs the bioengineering department are developing not only benefit the medical field but Utah's economy as well, as Andrade points out. "Our programs bring in federal money and jobs to the state," Andrade says. "We're also training a resource of people for the community and producing valuable technology."

Andrade finds one of the most rewarding aspects of his job is not necessarily being on the cutting edge of medical technology, but working with his students and helping them to develop their own ideas. "It's rewarding to see my students make a transfer from the mind set of a textbook approach to problems to a more creative, independent mind set," Andrade says. "When you see the creative spark develop, it's very rewarding."

Andrade, a California native, was intrigued and somewhat concerned when moving to Utah with his wife in 1969, and expected to stay only two to three years. But 21 years later he is still here. "We like the community," Andrade says, "and appreciate some of the influences of the LDS church, such as their emphasis on the family." However, Andrade notes that Utah isn't without its drawbacks. "Utah's disadvantage is that it's a very sheltered environment culturally," Andrade comments. "The ethnic population here is relatively small."

Andrade also enjoys the recreational opportunities available in the area such as hiking and cross-country skiing in the Wasatch Mountains. But having a job with as many demands as Andrade's does leaves little time to enjoy it all.



Dr. Joseph Andrade

#### Dr. Donald Lyman

In the Energy and Mineral Research Lab on the University of Utah campus, Dr. Donald Lyman holds what appears to be merely a piece of white, rubber tubing. The rubbery object is actually a life-saving artificial blood vessel and is the culmination of more than a decade of research.

Seated in his campus office, dressed in blue jeans and running shoes, Lyman's unassuming appearance doesn't reveal his distinction as Professor Emeritus. However, behind the steel-rimmed glasses, framed by silver hair, is a man who is known for his pioneering efforts with the polymer material used to create the small diameter artificial blood vessel.

Lyman's work in developing polymers for use in the human body began in 1965 at the Stanford Research Institute. In 1969, the Illinois native moved to Salt Lake City to continue his research in polymers and to teach at the University of Utah. When Lyman began doing polymer research few scientists believed a

weekend rates you can really go to town.

early economic tremors, he said.

But look at the film, and it seems that Moore does fudge his facts. His narration claims the big-money schemes were "the last great idea" that the city had. That makes the movie's story more outlandishly attractive, and paints the city boosters as more buffoonish than they really were. The suggestion is that the more they failed, the more desperately they spent huge sums of money.

So? Moore is perhaps guilty of a spanking offense. But the controversy lingers, in part because of his annoyed defensiveness whenever the subject

comes up.

Moore has encountered a larger, more ironic problem. He's getting a reputation for his Roger Smith-like tendency to duck the press. During his appearance at the United States Film Festival, he proved so elusive that Channel 2's film reporter instead created a "Michael and Me" segment on her efforts to find him. (On a personal note, he did not show for his scheduled interview with me. I should add, though, that I later caught him for an impromptu interview on a Park City sidewalk, and he agreeably answered a few questions.)

Common sense would dictate that there's nothing wrong with Moore's stance. The average person does not want to be constantly interviewed, filmed, or trailed by reporters.

Trouble is, Roger and Me is based on a different premise: If you stalk a VIP with a camera (or even notebook) and he avoids you, he must be hiding something.

Moore has been hoisted on his own muckraking premise. But his querulous, powerful film compensates by zeroing in effectively on a lot of other targets. •

by Rick Brough

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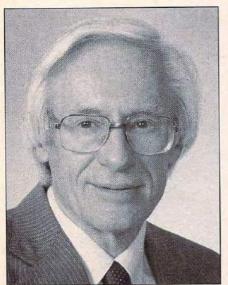
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used in the development of other artificial organs such as the artificial ureter.

The success Lyman has achieved is monumental in most men's eyes, yet he still isn't satisfied. "I'm now researching the cause of slow regeneration of tissue which could eventually lead to 'no- implant implants'," Lyman says.

Outside the lab Lyman spends his time gardening, cabinet-making and currently is collaborating with his wife, Liz, on writing a book on his research. The couple is also answering the question of "Who Done It?" in a murder mystery



Dr. Donald Lyman

polymer molecule could be compatible with the human body, but Lyman was confident it could be done. "You have to be an optimist to do this kind of work," Lyman says.

Lyman's breakthrough in polymer research came in 1976 when the first artificial blood vessel was successfully implanted in an experimental animal. Ten years later, Lyman's artificial blood vessel has been approved for implantation in humans.

Before Lyman's small-diameter blood vessel was approved by the Food and Drug Administration, the primary procedure for patients needing blood vessels (estimated between 300,000-500,000 each year) was to have one transplanted from one area of the body to another, a procedure still practiced today.

The polymers developed by Lyman are not only being used in the small-diameter artificial blood vessel, but are also being

Dr. James Parkin

Lyman doesn't have the answer yet, but even when this question is answered, there are plenty more to be asked. "My questions," Lyman says, "will go on forever."

#### James Parkin, M.D.

't was early one Saturday morning when Dr. James Parkin, M.D., received a call at home from one of his patients, Scott Shepherd, a restaurant manager and owner. It wasn't an emergency phone call; Shepherd just wanted to talk.

About 30 minutes later, Parkin hung up the phone and described to his wife, Bonnie, the phenomenal conversation he had just had with Shepherd.

Just four years earlier, Parkin's conversation with Shepherd wouldn't have been possible, because Shepherd was profoundly deaf and until recently wasn't able to hear the telephone ring, much less carry on a telephone conversation. That is until Parkin implanted Shepherd with an artificial ear which now allows him to not only hear the

phone ring but also to hear a dog bark, a jet fly overhead and many other sounds most people take for granted.

Parkin is, to many of his patients, a miracle worker; he has given back to them one of their senses, the ability to hear, something his patients thought was lost forever. Parkin has been able to do this through a device he and a team of researchers developed called the Cochlear Implant System or the Ineraid(tm) artificial ear.

The Ineraid(tm) works through a series of electrodes that are implanted into the cochlear, adjacent to the hearing nerve. These electrodes are connected to a microphone that is worn on the ear and which transfers sounds to a sound processor, typically attached to the patient's

The Ineraid(tm) is implanted only in patients who are post-lingually and profoundly deaf, meaning that their hearing was lost after birth and they are unable to hear or understand speech with the help of a hearing aid.

This Utah native first implanted the Ineraid(tm) artificial ear in 1975 after spending three years researching the device at the University of Utah's Division of Artificial Organs. The original artificial ear didn't have a portable sound processor so University of Utah bioengineers began work on miniaturizing the device and in 1983 completed a smaller, portable version.

Parkin is now starting an artificial ear implant program for children at the University Medical Center, using an artificial ear designed in Australia. Currently the Ineraid(tm) is only implantable in patients who are 18 years or older. "We're in the Model-T era of implants," Parkin says. "There's still a lot of research to be done."

So far 45 patients have received Ineraid(tm) implants at the University of Utah and about 200 patients have been implanted with the device worldwide. Parkin hasn't implanted all the Ineraids(tm) but has trained doctors around the world in the procedure.

Without his lab coat or surgical greens on, Parkin considers himself an average family man who enjoys church work and spending time with his four sons, ages 17 to 25. "It's wrestling season you know," Parkin comments. Which means he's been spending more of his evenings in local high school gyms watching his youngest son compete.

When the cheers from the wrestling fans rise to a high pitch, Parkin can be satisfied in knowing his patients are now able to hear the same cheers. .

by Nancy Volmer

#### CURRICULUM UPDATE

- Professor assigns his students to create science exhibits
- Survey finds colleges are dropping theater-directing programs

The new science center under development in Utah needed exhibits, so Joe Andrade decided to put students to the task at the University of Utah.

Mr. Andrade, a professor of bioengineering at Utah, also happens to be chairman of the program committee for the science center. He taught a course last spring for 15 students in which they designed exhibits for the center. It is several years away from opening, but the exhibits will first be part of a traveling science center, called "Leonardo on Wheels" after Leonardo da Vinci. It will travel the state in 1996 to celebrate Utah's centennial.

The course brought together students from varied majors to work in teams. Their mission was to devise a hands-on, interactive exhibit for the center.

"Leonardo was a renaissance man—an artist, an engineer, a scientist," he said. "That's what we're trying to get across: that creativity involves looking at things from multiple perspectives."

The students were divided into six teams, each of which created a prototype exhibit and presented it to the program committee of the science center. One team proposed an exhibit in which visitors would view bones in their own hands using ultrasound medical-imaging technologies. Another devised a recycling exhibit in which plastic

foam containers would be chopped up, melted, and made into something else. (The team made a sculpture of Leonardo.) Others proposed exhibits involving angular momentum and visual perception.

All of the projects need further development, Mr. Andrade said, and most of the students will continue working on them this academic year.

The course will be offered again next spring. —DENISE K. MAGNER

# **Bioengineering** (

# Sensors help test blood, inventions include needles

By LINNEA LUNDGREN Chronicle Feature Writer

Next time the doctor pokes a needle in your arm thank a bioengineer. Not for the shot, of course, but for the needle that

poked you.

Bioengineers are the people who help develop medical instruments such as needles and syringes, X-rays and CAT scans, diagnostic aids and chemical tests for blood analysis. Almost all the technology used in medicine falls under the scope of bioengineering.

In short, bioengineering is the application of engineering principles, methods, philosophies, instruments and technology to biological and

medical problems.

"The bioengineering department at the U. has historically focused largely on medical-related problems, so we collaborate extensively with the medical school and the health care community," Joseph D. Andrade, chairman of the department of bioengineering at the University of Utah, said.

Bioengineering is a rapidly expanding field.

expanding field.
One of the main reasons for its growth is the public's demand for more health care.

care.

"When something does go haywire [in a person's body], the attitude of the American public is to fix it im mediately. People don't want to grin and bear it.

There is an expectation in the community for good, effective health care," Andrade said.

What makes bioengineering so unique among other engineering fields is its interdisciplinary nature. While bioengineering has a broad focus in the sciences, it is not superficial.

"Bioengineering is not just a dabble in different science areas. Graduate students enrolled in bioengineering are expected to be proficient and knowledgeable both in the life sciences and in the physical sciences," Andrade said.

Bioengineers can be thought of as a "mix" between an engineer and a physician. Instead of having an engineer on one side and a physician on the other side trying to develop medical instruments, the bioengineer is a hybrid. Bioengineers are fluent in both medical and engineering topics and jargon.

Xiao Mi Tong, a graduate student in bioengineering, said she became interested in bioengineering because it incorporated biology with engineering. Presently Tong is working on a project dealing

with neurotissues.

Tong's project is one of many research projects in the bioengineering department. "We are trying to find a method to keep these tissues alive after they are removed from the body," Tong said. "When the tissues are removed from their environment inside the body, the new environment is quite different. We are trying to find a way to 'build' an environment

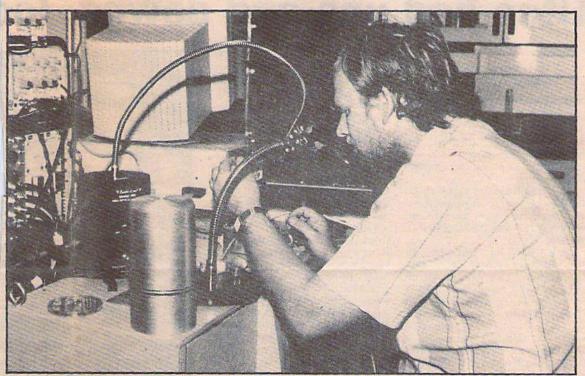
"Popping a pill into your mouth delivers a drug as a pulse and that's not the way your system likes to behave," Joseph D. Andrade, chairman of the department of bioengineering, said. "We are looking for a controlled, programmed way to deliver drugs which is easier on the body."

that is similar to that of the inside of the body."

One of the most successful projects in bioengineering (in conjunction with the U. radiology department) is diagnostic imaging.

Diagnostic imaging incorporates complex scientific principles into useful imaging tools such as X-rays and CAT scans. These devices allow

# lept. advances medicine



CHRONICLE PHOTO/Boone J. Chen

Andreas Pungor works on one of many projects in the University of Utah's bioengineering department. Bioengineering is an area rich in cross-disciplinary study combining engineering and medicine to produce revolutionary new technologies.

physicians to enter the body non-evasively and image various organs. Sophisticated engineering and computer technologies are needed to make diagnostic imaging equipment function and as a result the equipment is expensive. But, on the other hand, diagnostic imaging has greatly improved the ability to diagnose cancer and other serious aliments.

In collaboration with the U. pharmacology department, the bioengineering department is working on a system designed to deliver drugs to patients at a controlled rate.

"Popping a pill into your mouth delivers a drug as a pulse and that's not the way your system likes to behave." Andrade said. "We are looking for a controlled, programmed way to deliver drugs which is easier on the body."

Another project that is being developed is biosensors. These are primarily devices designed to measure chemical concentrations in blood, urine, tears and other biological fluids. Not only do these instruments measure simple chemicals, but also very complex bio-chemicals in the body.

Through the use of a

biosensor, a laboratory technician is capable of doing 700 to 800 tests on a blood sample. However, 800 tests have never been done on a blood sample because the physician wouldn't know how to handle all the information generated from the test.

"We don't know how those tests correlate with different disease stages, different moods and different conditions. There is an enormous effort to try and make it easier and cheaper to get more chemical information from bodily fluids and also to use that information as a research tool and eventually as a diagnostic tool," Andrade said.

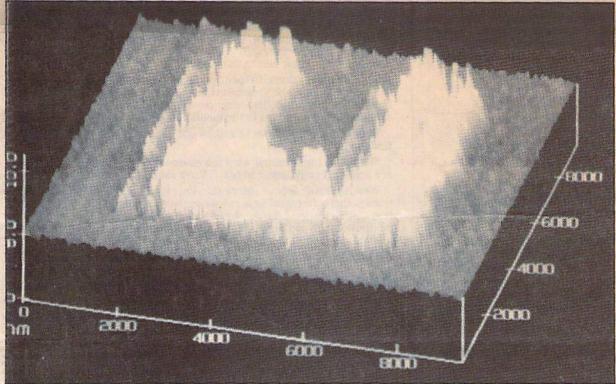
This is where the department of medical informatics at the U. Medical Center enters the picture. The medical informatics department is another branch of bioengineering with a different focus. One of this department's projects is to attempt to decipher the huge amount of information that is generated by such instruments as the chemical biosensors.

"With all these projects we are pushing the limits of science," Andrade explained. "People tend to think there is all this 'discovered knowledge' out there and engineers just come along and take parts of that knowledge and apply it to projects. That is not the case." "We don't have enough

"We don't have enough scientific knowledge to do many of the projects we are working on. So we are 'doing' fundamental science. We are doing the science ourselves or encouraging scientists to get the information we need. There is a positive synergism between science and engineering. As bioengineering requires the need for science, science in turn is driven in different directions."

Andrade said that for students who enjoy science—both in the biological and engineering aspects—the bioengineering program offers exciting career opportunities.

"Right now our graduates have no problem being placed in a job. The biomedical industry is one of the major growth industries in Utah." Andrade said. "As a proportion of the total number of jobs in the state, it is still not a major player, but it is growing rapidly. The state expects that in the early years of the 21st century biomedical industries will be a major employer in the state."



Protein fibrinogen, as seen through an atomic force microscope, was rearranged to form a "U."

# New microscopes at U. let scientists get close-up look at atomic features

Seen any good atoms lately? That's what University of Utah scientists are looking at under their newest microscopes.

The U.'s new atomic force microscopes will allow scientists to study interactions of proteins with DNA molecules and the interactions of enzymes with substrates.

"Atomic force microscopy is an entirely new method of providing images of submicroscopic features on the surfaces of materials," said Joseph D. Andrade, chairman of the department of bioengineering.

The newest microscopes combine the principles of a scanning tunneling microscope and a stylus profiolometer.

With the capability to study single atoms and rearrange them individually, scientists hope to create a new generation of "designer materials." The result of this process of nanoengineering could be an entirely new process for manufacturing products.

Andrade's group also expects to use the new microscope to observe the surface structure of the complex biomedical polymers known as polyurethanes, which are widely used in artificial hearts, heart-assist devices and other medical products.

Studying proteins at surfaces is important in the development of materials and devices used to measure chemical concentrations for medical diagnoses. A key to expanding knowledge about proteins is the mapping of the human genome, the complete set of an individual's genes. The genome could number as many as 10 million genes made up on DNA molecules.

The microscope probes the elec-

tron atmosphere of a surface, measuring the tiny forces that exist between atoms. The instrument charts the distance to the surface in terms of how strongly the atoms repel or attract each other.

To obtain an atomic-scale image, a material specimen is mounted onto a piezoelectric crystal and scanned beneath a sharp diamond tip attached to a cantilever, a beam supported only at one end. The diamond-tipped stylus moves across the surface, and the forces between the material's surface and the tip deflect the cantilever. The scope monitors the deflection in response to forces exerted on the cantilever.

The tip traces the shape of the surface, similar to the way a phonographic needle traces the surface of a record. The measurements are later assembled into a computerized picture of the surface.

#### U. research team developing sensors to monitor blood, biological functions

A University of Utah research team is developing fiber optic biosensors about the size of a small fountain pen that someday may revolutionize the monitoring of a patient's blood chemistry and other biological functions.

Dr. Joseph D. Andrade, professor of bioengineering, says the federally funded project is in its initial stages of development, and five to 10 years of research may be needed to develop a prototype device.

Andrade, former dean of the College of Engineering, heads a research group of bioengineers whose goal is to design and build remote biosensors made of optical fibers capable of continuously and simultaneously monitoring specific biochemicals in a person's blood and in other body fluids.

The fiber optics are the same as those used in the communication and computer industries — glass threads less than a millimeter thick.

According to Andrade, the longrange goal is to develop not just one biosensor for one biochemical, but a biosensor equipped with an array of detection channels. That way, instead of investigating biochemicals individually, the device could evaluate as many as 100 biochemicals simultaneously.

"The goal is to be able to measure virtually any biological function now measured in a typical clinical or biochemical laboratory, but do the monitoring on the end of an optical fiber. Such direct, online, multiparameter measurements would permit the nological or antibody-producing physician to monitor a patient closely and more effectively adjust anticoagulant therapy and regimens and drug dosages."

The real challenge confronting the research team is not as much one of making a miniaturé device but of creating a device capable of detecting numerous biochemicals simultaneously and continuously.

Andrade sees no need in the early stages of the project to make the sensors small or totally implantable. "What we're shooting for is sensors that will fit inside a piece of tubing to monitor flowing blood as well as other solutions."

The project is a multidisciplinary effort involving three of Utah's Centers of Excellence at the university: the Center for Biopolymers at Interfaces; the Center for Sensor Technology and the Center for Controlled Chemical Delivery.

Developing these immunosensors to function reliably in blood or other biological environments is still in its early stages, says Andrade. "As the work progresses, one can envision the production of multichannel biosensors based on microintegrated devices incorporating biochemical, optical and even electronic functions."

The research approach is based on what is known in clinical laboratories as "immunoassay," which involves analyzing the characteristics of a bodily substance by testing its immureactions.

The sensors operate by fluorescence. Light, directed along the fiber to the sensing surface, excites the bound molecules, producing fluorescence. The fluorescent light is collected and directed through the same fiber to a remote detection system.

The research is funded by the National Science Foundation, the National Heart, Lung and Blood Institute and the U.S. Army. Other professors involved in the project are Douglas A. Christensen, professor of electrical engineering and chairman of the department of bioengineering; James N. Herron, research assistant professor of bioengineering; Robert F. Boehm, professor of mechanical and industrial engineering; Hanson Y.K. Chuang, research associate professor of bioengineering; Jindrich Kopecek, visiting professor of bioengineering; and W.M. Reichert, research assistant professor of bioengineering.

The project involves graduate students in bioengineering, materials science and engineering, mechanical engineering, electrical engineering and pharmaceutics.

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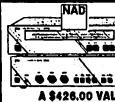




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CARMA WADLEY, FEATURE EDITOR, 237-2150

FEATURES . DEAR ABBY . MEDIA MONITOR . DO-IT MAN . TV TODAY . COMICS

By Elaine Jarvik Deseret News staff writer

cience really isn't as hard as it looks, Joe Andrade reminds us. Despite fancy words like dysprosium and meiosis, science is actually quite simplistic. It's basically common sense based on observations of the world.

Scientists, says Andrade, are really 2-year-olds with a good salary.
Andrade is a bioengineer, a professor at the University of Utah and co-director of the Us Center for Integrated Science Education. This year he is also the creator of "Science Without Walls," a science telecourse that begins Tuesday, Oct. 1. on KULC (Channel 9).

A lot of people are afraid of science, says Andrade, and that's partly because of the fragmented way in which most science is taught. The typical high school teaches biology first, then chemistry, then physics, when in fact all three disciplines are interrelated.



# BAD FIAR ENTROPY COADSIDE PHYSICS

To demystify what scientists do, Andrade explains the three basic disciplines like this:

"The purpose of physics is to learn the rules of the game. The game is life on earth. Chemists use the rules to understand the stuff of the physical world. Gas stuff, liquid stuff, solid stuff. Everything relates to stuff. Biologists use the rules and the stuff to try to understand life."

We're actually all "junior physicists," says Andrade. "We've all had to learn the rules of the game, otherwise we don't function." Gravity, inertia, velocity, acceleration, friction — "we all intuitively know what they are because we use them every day." If we didn't, we'd fall over.

"As Einstein said. All of science is nothing but a refinement of everyday thinking.' " Assuming, Andrade adds, that the science isn't relativistic quantum mechanics, which he also defines as "little tiny

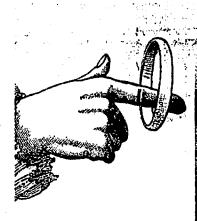
physics at very fast speed."
What we can best understand is what he calls "big physics at slow speed." You and I, he says, "operate down here in the ponderous, New-

ways in which all the sciences are the same. Better to talk about how scientists observe and investigate and record the world. Better to start with concepts like constancy, systems and disorder.

Disorder — known to you as a messy house and to science as entropy — is one of Andrade's favorite concepts. "Entropy Wins!" proclaims his license plate holder.

Entropy makes an appearance in several of the 40 segments Andrade has taped for "Science Without Walls." The program airs on the university's learning channel in 10 two-hour blocks on Tuesdays from 7 to 9 p.m. (rebroadcast on Thursdays from 7 to 9 p.m.).

Although designed primarily for undergraduate non-science majors, the course is sufficiently entertaining to appeal to anyone who wants to understand the world better. Bioengineer who creates I v series says science is truly not that valling.





Looking at the world, both big and small, slow and fast, in a rational, objective way is what scientists do. "They ask questions OF the natural world, not ABOUT it. And they expect the natural world can give them answers. Philosophy, on the other hand, asks questions to which the natural world can't respond."

"Science Without Walls" brings science to such disparate everyday phenomena as Teffon and home equity loans, guns and Bobby McFerrin, air bags and bad hair days. And hair in general.

In one segment, Andrade takes a strand of hair to a testing lab in Research Park to point out how even that boring staple of high school chemistry — the Periodic Table — hits home. Human hair contains 60 of the 92 elements.

"We're walking, talking Periodic Tables."

#### The physics and biology of the interstate

Biology: You're driving on I-80 at 65 mph when suddenly the driver in front of you slams on his brakes. It takes one second for your mind and body to react — to sense what is happening and do something. At 65 mph, that means you will have traveled five car lengths in the time it takes you to touch your brakes.

Physics: At 65 mph, it takes 10 more car lengths for the car to come to a complete stop. That's a total of 15 car lengths, compared with the usual 3 or 4 car lengths (not counting tailgaters) most drivers keep between themselves and the cars in front of them.

More physics: Kinetic energy (the energy an object has because of its motion) is roughly equal to the mass (in this case your 2-ton car) times the square

of the velocity. A car going 75 mph has nearly twice the kinetic energy it would have at 55 mph. And

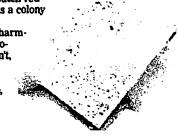
energy doesn't just dissipate. When your car, which had been traveling 75, suddenly stops by ramming into the car in front of it, the energy turns its attention to crumpling metal and crunching bones.

#### The dirtiest spot in your house

If you're looking for thriving bacteria, you don't have to look farther than the sponge in your kitchen sink. Bacteria need moisture and something to munch on (like a few microscopic remnants from last night's dinner). If you don't believe there are bacteria living on your kitchen sponge, you can try a little experiment.

Put a drop of water from the sponge on special film (you get one as part of the Science Without Walls kit if you're taking the course for University credit), put the film in a warm place for 24 to 48 hours and watch red specks appear. Each speck represents a colony of bacteria.

Most of the bacteria probably are harmless, says "Science Without Walls" professor Joseph Andrade. If they weren't, "they would have already wiped out the world's cooks." But if you've washed raw chicken with the sponge, says Andrade, throw the sponge out.



# LOW-TECH Rx

# Will Utah-developed home tests be the antidote for high health costs?

#### BY LEE SIEGEL

#### THE SALT LAKE TRIBUNE

High-tech gizmos improve medical care but send costs spiraling. Now there is a push to develop technologies that reduce, rather than raise, health care costs.

One way to save money is for people with chronic ailments to monitor their conditions at home. Diabetics and people with high cholesterol use do-it-yourself blood tests to check sugar or cholesterol levels. That lets them fine-tune their diet and drug doses, reducing the odds they will get sick and need expensive care.

University of Utah researchers and a spinoff company plan to develop inexpensive, at-home tests for other conditions, including PKU and galactosemia—inherited metabolic disorders that cause mental retardation if untreated.

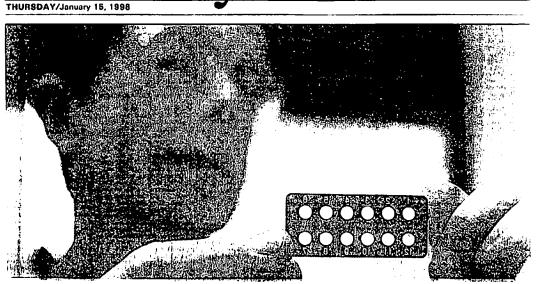
The researchers also hope to develop a home test kit to measure blood levels of homocysteine, which increases the risk of heart disease, said project leader Joe Andrade, a professor of bioengineering and pharmaceutics.

"We're very interested in patient empowerment—that is, to get the patient to assume greater interest and responsibility in the monitoring of their personal health," Andrade said.

The effort involves more than developing new medical tests. U. economist Norm Waitzman and political scientist Robert Huefner will study whether home test kits really produce health care savings, Andrade said. Bioengineer-anesthesiologist Steve Kern will teach students about money-saving medical technologies and exchange data with researchers running similar projects.

The Utah effort is part of the Cost-Reducing Health Care Technologies program run by the nonprofit Whitaker Foundation and the National Science Foundation (NSF). Last year, the program

Daybreak & SCIENCE



University of Utah professor Joe Andrade shows a prototype of a home test that would allow people who suffer from metabolic disorders to better monitor their own health more cheaply.

#### Home Tests: Low-Tech Health Care

**■** Continued from C-1

awarded a three-year, \$769,328 grant to Andrade's team.

That is about half the total cost of the \$1.5 million project at the U. and Andrade's private company, Protein Solutions Inc. The rest is financed by the NSF and National Institutes of Health. The company will produce the home test kits and pay royalties to the

About one of every 50,000 to 70,000 babies is born without an enzyme needed to process galactose, a form of sugar found in milk products. Absence of the enzyme causes galactosemia, or high galactose levels in blood.

Throughout life, people with galactosemia must completely avoid milk and milk products, as well as certain fruits and vegetables. Without such a diet, infants with galactosemia become mentally retarded, remain short and often develop cataracts. Even with treatment, many have speech problems and diminished IQs.

PKU, or phenylketonuria, afflicts one in 16,000 U.S. newborns. They lack an enzyme to process phenylalanine, an amino acid toxic to the brain. If the disorder is not treated, phenylalanine builds up in the blood, causing mental retardation, seizures, vomiting, aggression, hyperactivity and a "mousy" body odor.

PKU patients must sharply limit consumption of phenylalanine, which is found in meat, milk and other natural proteins. They can eat fruits, vegetables, certain grains and foods processed to minimize phenylalanine. Experts believe the diet is required for life to avoid decreased IQ and behavior troubles.

Pregnant women with PKU or galactosemia risk fetal damage if their disease is uncontrolled.

Hospitals in most developed nations now test blood from newborns to identify those with galactosemia, PKU and certain other inherited ailments. But there are no home tests to monitor galactose and phenylalanine levels in children or adults with galactosemia or PKU.

"If we had quick and easy tests like we have the finger-stick test for blood sugar [in diabetics], then we would be able to more tightly manage levels of phenylalanine and galactose," said Ed Clark, the U.'s pediatrics chairman and medical director at Primary Children's Medical Center.

"We don't have an easy way of measuring those now. It's done in the lab. The family doesn't get immediate feedback" on whether diet restrictions are working or must be followed more rigorous-

By helping patients stay on proper diets, home tests for PKU and galactosemia should reduce the incidence of retardation and other complications. That would "really save money as well as improve the quality of life" for patients, said Clark, an adviser to

Andrade's project.

Andrade said galactosemia and PKU test kits were picked as initial goals because available technology makes them feasible. The tests will use light-producing chemical reactions involving the chemicals ATP and NADH. Food is converted into ATP, which cells use for energy. NADH is related.

"All life on the planet is dependent on these two molecules," Andrade said. "They power or fuel every living cell, every living thing from the most primitive bacteria to you and me."

Fireflies glow in the dark using chemical reactions that involve ATP. Existing tests use those reactions to detect ATP and thus living cells. Such tests check for bacterial contamination in hospitals and food-processing plants, Andrade said. The more bacteria, the more ATP and a brighter glow in the testing device.

ATP also is involved in metabolism of galactose. Andrade envisions a home test in which ATP and an enzyme are added to person's blood sample. If galactose levels are normal, the ATP won't be consumed and the test device will glow greenish-yellow. Higher, unhealthy galactose levels will consume ATP, so there will be a dimmer glow or no glow at all.

Human eyes can't distinguish slightly different glow intensities that represent varying galactose levels. So Protein Solutions developed a prototype test kit: a glass microscope slide with 12 tiny, round wells to hold test chemicals and blood. More glowing wells mean lower, healthier galactose levels.

Glass slides are fragile, and people won't want to dribble their blood into 12 tiny holes. So the final version of the test device will be a thermometer-like paper strip to which a drop of blood is applied, Andrade said. A longer glowing line means low galactose levels; a shorter glowing line means higher, unhealthy levels.

An at-home test for harmful phenylalanine in PKU patients would use similar reactions involving NADH instead of ATP, and the light-emitting reactions found in flashlight fish instead of fireflies.

Andrade, a co-owner and founder of the five-employee Protein Solutions, hopes both tests will be developed within 2½ years. He said it will take 5 years until they are available because the company must obtain financing and government approval.

The company also hopes to use light-emitting ATP reactions to develop a home test for homocysteine, allowing people to monitor another heart-disease risk factor in addition to cholesterol.

Another test would monitor lactic acid levels in blood, helping top athletes train more efficiently, Andrade said. Lactic acid is produced during vigorous exercise in the absence of adequate oxygen. Andrade said there are existing lactic acid tests, but he wants to develop a cheaper one.

Protein Solutions, based in the U.'s Research Park, is developing the tests because "it's the kind of project big companies and big investors don't like," Andrade said. "We would like to develop devices that are very inexpensive, so it's not very profitable."

# Layton kids go up a creek



ROBERT REGAN/Standard-Examiner

Joe Andrade, a University of Utah bicengineering professor, and fourth-grade students collect murky test-tube samples

from the Kays Creek segment the Layton Elementary School class plans to adopt as an outdoor classroom.

#### Adopt a Waterbody project aids study

By REBECCA WALSH 3-7-94

LAYTON — The children in Marilyn Morrison's fourth-grade class initially were less than thrilled when they discovered what their school had adopted. The 150-foot stretch of Kays Creek was pukey green, muddy and full of water skeeters

But their reluctance quickly faded, and they rushed down the banks.

Kids are fascinated with water," Morrison said. "I don't even mind them getting wet,

getting into it if they're learning something."

On a hot day last week, Morrison and her 24-odd kids were the first to try Layton Elementary School's newly adopted water body, a segment of Kays Creek that meanders under Main Street and emerges behind the American Legion building.

For three weeks the class at the year-round

school had been studying bioluminescence in the relative sterility of their classroom with the help of a University of Utah professor and two of his students. Using sealed plastic bags full of dinoflagellates, small plants and animals that glow in the dark, the kids conducted simple experiments to learn the scientific method and the meaning of the words "hypothesis" and "conclusion." But June 28 was the day that made all the difference the day for their creek excursion.

You can talk about water quality and ecosystems in the classroom and do all kinds of wonderful things," said <u>loe Andrade a U of U bioengineering professor</u>, "But there's nothing like getting them out. The only way to make book learning relevant is to bring the outside world in or take them outside. They know the difference."

Ben Haake prepared well in advance for the class field trip, bringing his own portable microscope to the creek. He opened the case in the dust and prepared a slide with murky water. "There are all kinds of bugs down there," he said. "Beetles and water skeeters."

At the creek, the other children fell into the water, slopped mud between sneaker-clad toes

and scooped up test tubes of dirty water. They're just loving this," Morrison said.

It's a scene Janet Call, an auxiliary leader for the Utah Association of Conservation Districts, wishes her own kids could have experienced before they left Layton Elementary. Call convinced administrators and PTA rep-

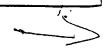
resentatives at the school to adopt the creek-side land as an outdoor classroom.

The Adopt a Waterbody program is rela-tively new in Utah and nationwide. Under a 1992 Environmental Protection Agency Pollution Prevention Grant, states are given access to money for accepting stewardship over a body of water, said LeahAnn Lamb, environmental scientist with the Utah Division of Water Quality.

The only requirement to adopt a piece of water is that the land and water be cleaned up twice a year, she said.

Call's project is more advanced. She envisions raising the segment of the creek to its

See WATER on 2C



#### Water

From 1C

original level. planting trees, building an amphitheater and maybe even adopting the entire length of Kays Creek from Hobbs Reservoir to its mouth at the Great Salt Lake. "It may take years, but it's something we can do."

Lamb said several schools already have adopted other bodies of water. A Park City youth group called Earth Kids from Treasure Mountain Middle School adopted a seven-acre wetland in their neighborhood. West High School students have adopted part of the lordan River that runs in north Salt Lake County. "This has all

evolved by word of mouth." she said.

The state program combines effort from the Department of Environmental Quality, the Division of Natural Resources and the Department of Agriculture.

Adopt a Waterbody of Utah received a \$10.000 grant to be dispersed among water stewards. Lamb said her office will accept applications for grants this summer. To receive money, groups have to be involved in interagency partnerships of their own, involving city governments, schools or the Soil Conservation Service, for example: "We want to see people forming these coalitions. They have to prove their commitment." Lamb said. "We want people to gain a sense of ownership of these resources."

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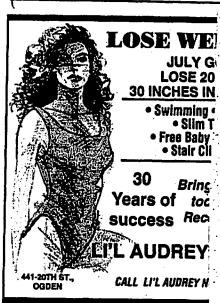
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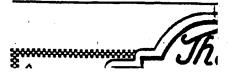
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#### Education in Gel

# Teaching elementary science: it's not answers, it's questions

The worst place in the world for future teachers to learn how to teach science is a university.

That statement comes from a University of Utah science professor.

He's Joe Andrade, a professor in U of U's Department of Bioengineering. He's building a center to help elementary teachers teach science.

(Teachers: Need help? Call Professor Andrade at 581-4379, or write to him at 2480 Merrill Engineering Building, Salt Lake City, UT 84112.)

Andrade says future teachers don't learn how to teach the subject because these courses are designed for science majors— not students destined to teach the subject to fourth graders.

Some elementary education majors, confident about teaching arithmetic, social studies, language arts and other subjects, get nervous about teaching science, he concludes.

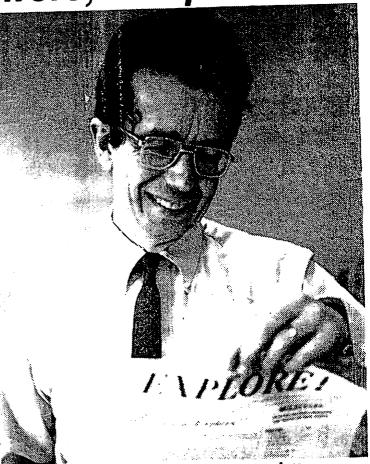
"They think they have to know answers, and feel they're failures if they don't," he continued. "But science is not knowing answers, but asking questions."

He said classroom science demonstrations "have to be useful, interesting, convenient—and successful."

If the show doesn't work, it results in teacher frustration.

Andrade is planning a science newsletter for teachers.

One feature of his prototype newsletter for teachers is an easy-to-produce reaction created



Joe Andrade and prototype newsletter

from mixing hydrogen peroxide and yeast.

The article takes the teacher from obtaining the necessary items for the demonstration through a line of questioning about results.

Andrade offers inservice sessions with elementary teachers, and he's organizing a pool of scientists to make this service

available to more elementary teachers.

If the professor has any questions about what's going on in the elementary classroom, he doesn't have to go far for answers.

His wife is Barbara Andrade, a teacher at Salt Lake School District's Nibley Park Elementary School.

# THE FLICE SHEETS MARRICHT CENTER FOR

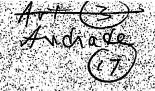
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# ATRES and Engineering

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Department of Bioengineering as Master of Ceremonies with

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"Computer Visualization in Medicine" Dr. Chris Johnson College of Engineering Computer Science

The Intelligent Stage: "Falling to Earth"

Guest Artist Ellen Bromberg

College of Fine Arts

Modern Dance

Animatronics in Ballet: "The Snow Maiden"
Performance by Utah Ballet Company
College of Engineering student Josh Gray
and
Assistant Professor Rick Wacko
College of Fine Arts
Ballet