NIH NATIONAL INSTITUTES OF HEALTH
UNIVERSITY OF CALIFORNIA

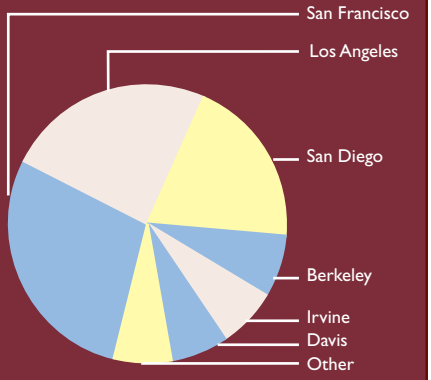
Office of Research, UC Office of the President, Spring 2002

On the cover:

In FY01, NIH awarded UC over one billion dollars to conduct research.

UC San Francisco is the third-ranked medical school nationally in terms of NIH research funding.

FY01 NIH research funding to UC by campus



Source: UCOP contracts and grants database

Inside:

UC's NIH research tops $1 billion

The National Institutes of Health awarded the University of California over $1 billion in FY01 to conduct research across the spectrum of the health sciences. The quality of research at UC has driven its NIH funding from $658 million in FY96 to $1.01 billion in FY01, an increase of 54 percent in five years.

The current revolution in the understanding of the human genome and other medical advances has led Congress to fuel improvements in the health of Americans through NIH research at UC and other colleges and universities.

NIH supports 35,000 grants and 50,000 principal investigators, mostly in medical schools and life science departments. NIH is on a five-year track to have its budget doubled, from roughly $13.5 billion in FY98 to $27 billion in FY03.

UC President Richard C. Atkinson has observed that investments in NIH have paid big dividends for Americans. "Deaths from heart attacks and strokes have been cut by more than 50 percent over the past two decades, with federally supported research playing a decisive role," he notes.

NIH supports research at all nine existing UC campuses and at the three national laboratories administered by UC. In FY01, over $288 million – or about 29 percent of UC's NIH research awards – flowed to UC San Francisco. One of the world's leading medical research centers, UCSF is the only UC campus dedicated to the health sciences. It is the third-ranked medical school nationally in terms of NIH funding.

UC Los Angeles received $244 million in NIH research grants, or 24 percent of UC's NIH total. UC San Diego captured $198 million in NIH research funding, or 20 percent of the UC's NIH total. Both UCLA and UCSD combine prominent medical schools with major programs in the life sciences.

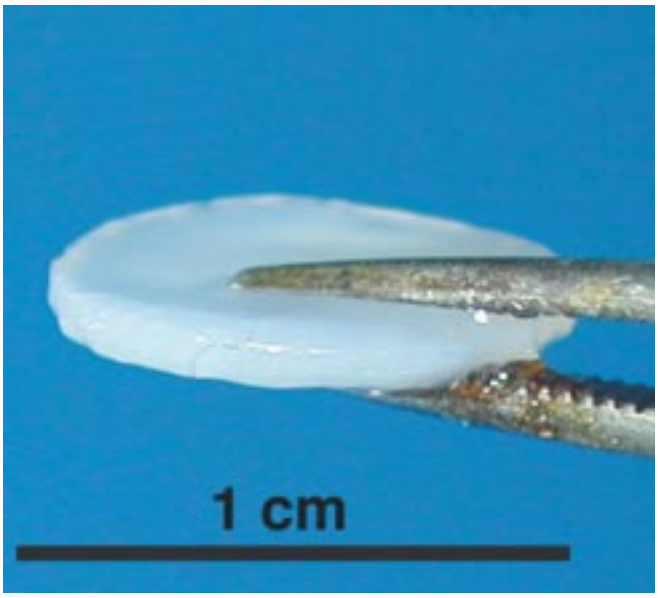
The quality of research at UC has driven its NIH funding from $658 million in FY96 to $1.01 billion in FY01, an increase of 54 percent in five years.

Two smaller medical schools at the Irvine and Davis campuses help boost NIH awards there. These two campuses each earned about $70 million in NIH funding in FY01.

UC Berkeley's strength in the life sciences earned it $72 million in NIH funding – over seven percent of the UC's NIH total. The three UC campuses at Santa Cruz, Riverside and Santa Barbara, along with the three national laboratories – Lawrence Livermore, Lawrence Berkeley, and Los Alamos – collectively garnered almost $68 million in NIH research funding.

The excellence of NIH-funded research at UC benefits the residents of California, the nation, and the world. NIH-supported research at UC will continue to produce medical breakthroughs to enhance human health everywhere.

Synthetic Cartilage



A piece of artificial cartilage grown in the laboratory of UC San Diego bioengineer Robert Sah.

With help from the National Institutes of Health, UC San Diego bioengineer Robert Sah has fabricated cartilage tissue that mimics the multi-layered structure and cellular functions of natural cartilage. "We hope this tissue can be developed as an implant treatment for the millions of people who suffer from cartilage damage associated with joint injuries, congenital defects and age-related degeneration," says Sah.

Cartilage is the body's shock absorber, a cushion of durable tissue that protects the knee from a lifetime of walking, bending and running. Though just a few millimeters thick, cartilage is nevertheless very complex, consisting of a surface, middle and deep region, each with its own distinct composition and structure.

Sah's success in creating cartilage is based upon his earlier research (also funded by NIH), where he described in detail what happens when cartilage is squeezed and flattened as it absorbs impact. It had been suspected that cartilage is relatively soft and flexible at the surface, but stiff closer to the bone. Sah's findings supported this theory and provided precise measurements of the differences in stiffness.

Sah's research team had used a novel technique to identify cartilage cells, called chondrocytes, within the cartilage tissue layers. As the team compressed the tissue, they recorded microscopic images of the shifting chondrocytes. These were the first detailed observations about compressive mechanical properties in different regions of cartilage tissue. The researchers found that the surface region of cartilage is 25 times softer than the deep tissue closer to the bone.

These results presented a blueprint for the mechanical properties of cartilage and how it works in the body, valuable information for Sah's next task – growing cartilage in the laboratory. Sah developed the bioengineered tissue in conjunction with Koichi Masuda and Eugene Thonar of Rush Presbyterian St. Luke's Medical Center in Chicago.

Sah and his colleagues created synthetic cartilage by organizing different types of chondrocytes to mimic the stratified nature of cartilage tissue. Then they grew this cell mix together by suspending cells in a gel until they began to form their own matrix or scaffolding, which stiffens the tissue. The gel then was removed, leaving an entirely biological tissue.

In laboratory tests, the researchers found that the cells at the surface of their engineered tissue effectively secreted a key molecule needed to lubricate the joint. In addition, the cells at the surface produced tissue that was softer and had a less dense matrix, while the cells in the deeper regions were spaced further apart and had a more densely packed matrix, making the tissue stiffer.

Sah and colleagues believe the engineered tissue will mature like cartilage does naturally in humans. During fetal development, cartilage cells are densely packed, and the matrix is loosely knit. But as a child grows and the matrix supporting the cartilage gets stronger, cartilage cells spread out. By the time an individual reaches adulthood, cartilage is mature, the cells become less active, and the tissue is about four times stiffer than it was during early development.

"We've designed a tissue made up of different types of juvenile cartilage cells," says Sah. "We hope the tissue can be implanted into a patient and grow up to conform to the specific geometry of the individual's joint."

The engineered tissue is like immature cartilage. Sah believes this will give the implant an advantage because as it continues to mature, it is likely to integrate well with the patient's surrounding cartilage and joint tissue.

"We can't replace aging knees," he adds, "but perhaps soon we will at least be able to give those knees new cartilage, and improve the quality of life for people with arthritis and for those who have simply worn out their knees."

Health Is Gold!

Public health outreach to Vietnamese-Americans

For more than 18 years, a dedicated group of UC San Francisco researchers has been fighting hepatitis-B, cervical cancer, smoking-related illnesses and other preventable diseases in California's Vietnamese communities. Their goal has been to "translate science to the streets" and to encourage a medically underserved population to seek preventive care.

The founders of the Vietnamese Health Promotion Project – Dr. Stephen McPhee (upper left) Chris Jenkins (right) and Thoa Nguyen (lower left) – pose with a visitor from Hanoi, Dr. Nguyen Ba Duc (center).

Under the guidance of UCSF professor Stephen J. McPhee, and with assistance from the National Institutes of Health, the Vietnamese Community Health Promotion Project has not only provided public health outreach, it has developed and published its community-based research techniques in the medical literature and shared its results with other organizations.

An estimated one million Vietnamese live in the United States, mostly first-generation immigrants who arrived in the years following the end of the Vietnam war in 1975. The Vietnamese are the fastest-growing Asian/Pacific Islander ethnic group in the U.S. By the year 2030, demographers predict that they will number nearly four million, constituting the second-largest Asian/Pacific Islander ethnic group in the U.S.

The Vietnamese Community Health Promotion Project was designed to help meet the health needs of this population. It got its start in 1985 when UCSF's McPhee joined forces with Chris Jenkins, a graduate of UC Berkeley's Master of Public Health program. Jenkins had worked on development projects in Vietnam and spoke the language fluently. He was also a survivor of Hodgkin's Disease, and he knew how difficult it could be for cancer patients to navigate the U.S. health care system – especially for those patients among the wave of new immigrants from Vietnam.

As an expert in preventive medicine, McPhee saw both a community in need and a chance to test models of health outreach to see how to most effectively target this community. McPhee hired Jenkins, and then recruited Thoa Nguyen, who as an activist and later the principal of a local Vietnamese school had strong ties to the local population.

Until Jenkins's death from hepatitis-C in April 2001, McPhee, Jenkins and Nguyen formed the core of the Vietnamese Community Health Promotion Project, better known as the *Suc Khoe La Vang!* (Health Is Gold!). They hired several members of the Vietnamese community, many of whom went on to get degrees in public health and other related fields.

McPhee and Nguyen have continued the project's work of conducting a variety of community-based assessment, outreach and intervention projects. They have targeted cervical and breast cancer screenings among Vietnamese women, prevention and cessation of tobacco use among Vietnamese men and youth, and hepatitis-B immunization among Vietnamese children.

Cervical cancer rates among Vietnamese women are the highest of any racial/ethnic group in the U.S. For breast cancer, the situation is quite different – Vietnamese women are at somewhat lower risk for invasive breast cancer in comparison with other women in California and the U.S.

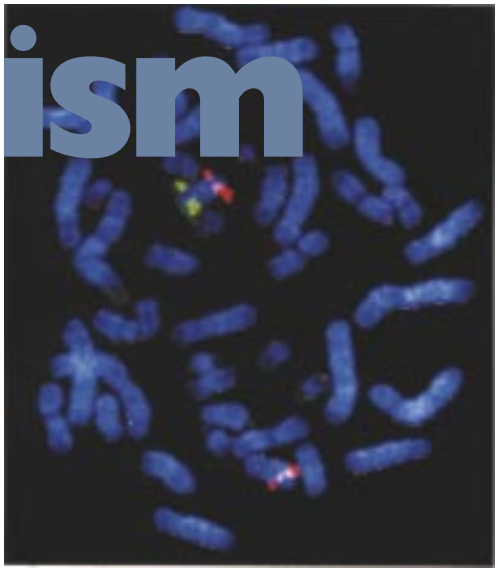
Unfortunately, among Vietnamese women, many surveys indicate that rates of screening for breast and cervical cancer are significantly lower than in the general population. Barriers to cancer screening among Vietnamese include limited education and English proficiency, limited access to health care, and social isolation.

To attack these problems, the health promotion project designed a study that encouraged Vietnamese women to host small gatherings of family and friends. In the sessions, these neighborhood leaders were trained to provide participants with

(continued on back page)

The Vietnamese Health Promotion Project's pamphlet on cervical cancer screening (center) was the basis for the National Cancer Institute's pamphlet (right).

Autism



Spence uses the FISH process to spotlight chromosomal abnormalities. Shown here is the normal complement of 46 chromosomes from a cell of an autistic girl. FISH fluorescent markers bind to genes on both copies of chromosome 15, revealing a genetic abnormality in one region. The red fluorescent markers bind to and light up on both copies of the chromosome, indicating the presence of genes commonly found in one region. However, the green fluorescent marker binds to and lights up on only one copy of chromosome 15, indicating missing genetic information on the untagged chromosome. The missing genes may be responsible for this child's autism.

UC Irvine geneticist M. Anne Spence is working to understand one of the most baffling diseases afflicting American children – autism. Under National Institutes of Health sponsorship, UC Irvine has been named one of 10 national Collaborative Programs of Excellence in Autism. Spence and other researchers will focus on genetic factors that play a role in autism.

Autism is a complex biological disorder of human development that causes problems with social interaction and communication. Autistic people appear to be lost in their own world and disconnected from ours. Children with autism may have trouble carrying on a conversation, or may not look at their parents or others. They may repeat certain expressions or behaviors over and over.

It is estimated that autism now affects somewhere between 10 to 20 children per 10,000, a steep increase since the 1960s, when the prevalence was estimated at four to five people out of every 10,000. It strikes Americans from all social and ethnic groups. Symptoms of autism appear around the age of 18 months, and boys are far more likely to be affected than girls. The causes of the disease are unknown and there is no cure, although medical and psychological therapy can improve the lives of people with autism.

The prevalence of autism appears to be on the rise, but much of this increase may be due to better screening and a broader definition of the various symptoms of what researchers now call *autism spectrum disorder*.

There is strong evidence that autism has a genetic component. Among identical twins, if one twin has autism, there is a 60 percent chance the other twin also has the disease.

Spence and fellow researchers are at the forefront of efforts to identify the missing or altered genes that might be a factor in autism. "Heredity has long been suspected of playing a major role in autism, but identifying specific genes that make people more vulnerable to autism has been difficult," says Spence. "It is most likely brought about by the interaction of multiple genes, each contributing a small part in causing the disease."

UC Irvine geneticist M. Anne Spence

Now that information from the human genome project is available, an intensive search is on to find the genes responsible for autism. In 1999, NIH-sponsored researchers scored a major victory when they discovered the genetic roots of Rett syndrome. This syndrome is a particularly debilitating member of the group of autism spectrum disorders. It is rare, occurring in about one person in 10,000, and almost always affects girls. Rett syndrome is caused by the mutation of a single gene that encodes a protein called MECP2. Without MECP2, the brain and nervous system cannot develop normally.

Spence and fellow researcher Moyra Smith are searching for other genes that play a role in autism. They use a technique called *fluorescence in situ hybridization* (FISH), a process that vividly paints chromosomes or portions of chromosomes with fluorescent molecules. This technique is useful for identifying abnormalities (see image above).

Using FISH, Spence and Smith have found a previously unknown genetic change in the DNA of an autistic girl. Spence discovered that the child's chromosome 15 was normal in the area q11-q13, a region where mutations are known to cause neurological impairments, and where mutations causing autism are suspected. But Spence also found that approximately 1000 base pairs, the fundamental building blocks of DNA, were missing from the child's chromosome 15 in the region q22-q23. "We found that a number of genes normally on the chromosome were deleted," said Spence. "This detailed information can help us try to match these deleted genes with suspected genes for autism and piece together how genes interact with the body to result in autism."

Many parents of autistic children have suspected autism is linked to childhood vaccinations, especially the measles, mumps and rubella (MMR) vaccine, which is typically given to children at about the time symptoms of autism begin to appear. Several studies in the U.S. and Europe have failed to show any link to childhood vaccines. However, many researchers believe autism is caused by the interaction of genetic and environmental or nutritional factors. "We do not know yet what the environmental factors may be," says Spence, "but vaccines are no longer considered prime suspects."

Researchers hope to understand autism and its genetic and environmental roots well enough to recommend special diets or medications that will improve the quality of life for people with the illness. But so far, adds Spence, "there is little to recommend in the way of medications, because we understand so little about the causes of autism, even though we have made tremendous progress in the last several years."

Another puzzle is why autism exists at all. Since autistic children are less likely to have the social skills or interests that would lead them in adulthood to have children, the syndrome might be expected to die out. One theory is that, as in sickle-cell anemia, autism-related genetic changes might confer an advantage in some cases, yet lead to illness in other cases when parents with a certain combination of genes have children.

Roughly 10 percent of autistic children are savants – they have outstanding skills in memory, music or mathematics. Cognitive research shows that autistic children display unusual thinking processes with *weak central coherence* – they see discrete details instead of patterns. They tend not to be fooled by optical illusions, but at the same time they are unable to interpret facial expressions. Similar traits often are shared – in weaker form – by other family members.

The complexities of autism have led Spence to what she calls her personal heresy. She advocates that researchers stop focusing on autistic individuals and instead collect genetic data on their families as a whole. Due to the genetic complexity of the illness, it will take very large samples of people affected by varying degrees to sort out exactly which genes play a role in which behavioral and cognitive problems. "By acting as a clearinghouse for data from across the U.S. and also foreign countries, and by supporting continued research, NIH is taking a major step in the right direction," says Spence.

NIH-funded autism research at other UC campuses

A drawing of the UC Davis M.I.N.D. Institute, scheduled for completion in March, 2003.

Many UC researchers are striving to better understand and treat autism. Listed below are examples of programs from several UC campuses:

UC Davis's M.I.N.D. Institute (for Medical Investigation of Neurodevelopmental Disorders) was founded in 1999 after two years of effort by four fathers who were frustrated by the lack of information and services for their autistic sons. The M.I.N.D. Institute is helping UC Davis establish a research center to study the possible role that environmental contaminants – pesticides, industrial chemicals and heavy metals – play in the development of autism.

UC Los Angeles has played a unique role in the history of research on autism. In the 1950s – considerably earlier than other major universities – UCLA had an active research program concerned with characterizing the disabilities of children with autism. The research and treatment conducted over the past 50 years at UCLA has set the standard for all models currently used to treat individuals with autism.

UC San Diego is home to the Laboratory for Research on the Neuroscience of Autism. This lab is dedicated to uncovering the brain physiology of autism. Magnetic resonance imaging (MRI) studies aim to identify the brain structures involved in autism and to describe their growth trajectories from infancy through adulthood.

UC Santa Barbara's Autism Research Center is part of the Graduate School of Education. The center strives to understand autism, as well as to improve elementary and secondary education opportunities for children with the disease. The center also provides a number of undergraduate, graduate and paraprofessional training programs that develop and teach effective treatment techniques. Research is conducted to assess the effect these programs have on family life, on the children's language and behavior, and on the degree of community and school integration.

Marine Pharma

UC Santa Cruz organic chemist Phillip Crews describes a new mass spectrometer that his research group uses in its studies of marine sponges.

In 1974, Phillip Crews was a young UC Santa Cruz assistant professor looking for a research project in organic chemistry. A student assistant brought him a book on marine biology entitled *Poisonous and Venomous Creatures of the Oceans*.

This *Jaspis* sponge is indigenous to the coral reefs that surround the Fiji islands. It is the source of bengamides, a family of compounds with anticancer properties now in clinical trials for use by humans.

Among pictures of marine sponges was text stating, "Chemistry: unknown." Crews laughs and says, "I knew right then what I wanted to spend my career working on."

Organic chemists have analyzed land organisms more completely than ocean organisms simply because they are more accessible. To an organic chemist, the ocean is a largely unexplored world of odd creatures with mysterious chemistry.

Crews has explored this unknown world extensively. After years of research and 30 to 40 expeditions to the islands of the Pacific Ocean, Crews has isolated over 800 pure compounds and thousands of extracts from marine sponges.

Crews is seeking unique chemicals with anti-cancer and anti-inflammatory properties that can be used safely as drugs. His most successful discovery to date is the bengamides, a class of chemicals isolated from *Jaspis* sponges indigenous to the coral reefs surrounding the Fiji islands. Bengamides are potent anti-cancer compounds and are now in clinical trials to test their safety and effectiveness in human subjects.

"Sponges are an exquisite source of chemical diversity," says Crews. Because they can't move to avoid predators, they have evolved intricate chemical self-defense mechanisms. Families of sponges have differentiated as they spread across the expanse of the Indo-Pacific basin, from Indonesia in the west to Easter Island in the east and Hawaii in the north. Different chemistry exists even within the same species of sponges across the region.

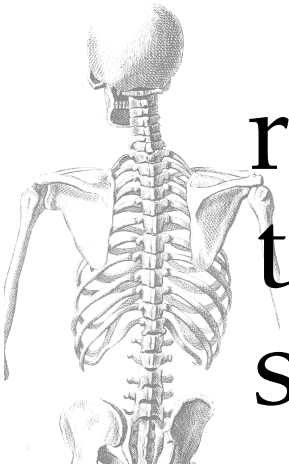
The development of Crews's research was shaped by the nature of UC Santa Cruz, a young and small campus with an emphasis on teaching and multidisciplinary studies. He took advantage of the SCUBA courses offered by the campus to learn to dive and collect his own samples. Later he learned to sail at UC Santa Cruz so he could rent boats cheaply in Polynesia and explore Tonga, Fiji and other islands with his research group.

To harvest the sponges and then analyze their chemistry requires a collaborative approach. Crews has concentrated on harvesting, preserving and extracting chemicals from the sponges, while pharmaceutical partners like Syntex (now a part of Roche) and Novartis have analyzed the compounds derived from the sponges. Crews is now beginning to explore deep water sponges along with the fungi that sometimes live symbiotically with sponges.

The National Institutes of Health are supporting the collaboration between Novartis and the Crews research group with a drug discovery grant. Crews also works closely on another NIH grant with Fred Valeriote at the Henry Ford Cancer Center.

Crews is working to overcome one natural disadvantage for the production of marine pharmaceuticals – lack of raw materials. Natural harvesting of large quantities of sponges is expensive and could be environmentally destructive. Crews hopes to understand the chemistry of sponges and their unique chemical compounds so that they can be synthesized in the laboratory.

"NIH helps us to expand and refine our research," says Crews, "including annual expeditions to select and obtain new sponges, and the ongoing study of the UCSC repository of Indo-Pacific sponges and extracts. With NIH support, we are learning more about the chemistry of sponge-derived microorganisms and the nature of deep water sponges – topics we are just beginning to explore."



retraining the spine

In UCLA professor Susan Harkema's lab, a quiet revolution is underway, one that may dramatically alter the ability of patients with spinal cord injuries to walk. Based on her research that shows the spine is capable of learning and coordinating walking independently of the brain, Harkema has trained some spine-injured patients to perform limited walking. "The ability to walk even a short distance with a walker, or to climb a few stairs with assistance, can really improve the quality of life for many spine-injured people," says Harkema.

About 11,000 Americans suffer spinal cord injuries annually, and many have permanent disabilities as a result. About 200,000 people in the U.S. have paralysis caused by spinal cord injuries. These injuries occur most often in young males, and are a result (in order) of auto accidents, shootings and other violence, falls, and sports injuries. Harkema's National Institutes of Health-funded research soon may lead to more effective therapy for people living with spinal cord injuries.

Harkema's research is part of a growing body of evidence that the brain is not the source of many of the nerve impulses required for walking. During the course of evolution, locomotion developed in creatures before the complex brain, so it's reasonable to assume that a task like walking may be triggered by nerve impulses in the spinal cord.

The theory was confirmed in the early 1900s, when cats with severed spines were found to be able to walk on treadmills. Convincing evidence for humans required decades of more studies. As the body of research grew, and devices to measure nerve impulses improved, researchers learned that in humans the spine was the source of rhythmic walking signals.

This scientific evidence was supported by anecdotal stories of spine-injured patients whose legs would walk spontaneously without voluntarily control, and by success stories in Germany of wheelchair-bound people who regained some ability to walk with locomotor therapy. This technique emphasizes retraining the spine to coordinate the nerve signals for leg movement.

Locomotor therapy stands in contrast to the accepted practice of gate therapy, which assumes that control of movement resides in the brain, and that only patients with partial spinal injury and some voluntary muscle control can relearn to walk. Although gate therapy involves the use of body harnesses to support the patient's weight over a treadmill, locomotor therapy goes further by providing appropriate sensory cues to the spinal cord by simulating normal kinetics of stepping. Locomotor training takes advantage of the growing body of evidence of independent spinal control. It has achieved wide acceptance in Germany and in some clinics in Switzerland, although in the U.S. it still is considered experimental.

UCLA researcher Susan Harkema (right) prepares a test subject with spinal cord injury for locomotor therapy.

UCLA has been a leading center of spine injury research for many years, and Harkema's lab is one of the few places in the country actively experimenting with locomotor training. "Although we think locomotor training has incredible potential," says Harkema, "our research group does not solely focus on developing clinical protocols for therapy. Our primary job is basic research to understand how the human spinal cord processes information and activates muscles during locomotion."

Harkema's research has sparked the interest of physical therapists, who often visit her lab with an interest in incorporating her research results into their therapeutic techniques. Soon Harkema will be participating in a large clinical trial of locomotor training that will require hundreds of patients and millions of dollars – far more patients and resources than a single lab can manage.

In the meantime, examples from Harkema's lab are promising. Four subjects with *clinically incomplete* injuries (some voluntary leg movement) regained the ability to walk after locomotor training. One subject with a *clinically complete* spinal injury (no voluntary movement in either leg) was able to stand again after locomotor therapy.

Even if patients don't relearn to walk, locomotor therapy seems to have major secondary benefits, including better muscle tone and cardiovascular fitness, fewer random spastic movements of the limbs, better circulation, and fewer bedsores and other infections. Says Harkema, "We are at the beginning of an explosion of interest in locomotor training as a therapy. In the next five years, I think we may see major changes in the approach to rehabilitation of many spinal cord-injured patients."

Public Health outreach to Vietnamese-Americans

(continued from page 3)

verbal and written information and to encourage them to receive screening tests. Brochures about breast and cervical cancer also were distributed, along with small gifts for participation. Incentive contests and annual community health fairs were organized to encourage women to complete screenings.

Thoa Nguyen of the Vietnamese Community Health Promotion Project distributes literature on cancer screening at a community fair in Oakland, CA.

The statistical analysis of this intervention was encouraging. The project found a clear association between a woman's attendance at an education session and her later receipt of the screening procedure discussed at that session. The results of this and other studies have been published in the *Journal of the American Cancer Society* and the *Journal of the American Medical Association*. The project's pamphlet in Vietnamese on cervical cancer screening has been adopted and reprinted by the National Cancer Institute.

The project now has joined the Asian American Network for Cancer Awareness, Research and Training. Coordinated by Ohio State University's Moon Chen Jr., the network is a five-year cooperative agreement between NIH's National Cancer Institute and Ohio State. Funded by the National Cancer Institute, the network addresses the common health care concerns of Asian American communities across the nation.

As a network regional director, McPhee has helped establish the San Francisco Pan Asian Council, with representatives from 18 Asian American groups in the city. The council's goals are to identify gaps in health education programs and access to cancer information, and to identify disparities in cancer incidence and mortality. "We're happy to be part of the network," says McPhee. "We are able to take the lessons we have learned over the years," he adds, "and apply them more broadly to prevent disease among all Asian Americans.

NIH and UC take a lead role in the fight against bioterrorism

Under President George Bush's FY03 budget proposal, the National Institutes of Health will receive a sevenfold increase in biodefense funding. The funding will accelerate bioterrorism research at UC and other research institutions to help strengthen the nation's ability to fight biological attacks. At NIH, the National Institute of Allergy and Infectious Diseases (NIAID) will take the lead for research on bioterrorism.

Under the FY03 budget request, NIAID's budget would grow by almost 60 percent, to $4 billion. New initiatives will fund research into high-priority, "Category A" biological diseases – anthrax, botulism, plague, smallpox, tularemia and viral hemorrhagic fevers. Many initiatives expand or build upon existing NIAID bioterrorism or infectious diseases research programs.

NIH is taking several additional steps to fight anthrax. One initiative seeks to accelerate development of new vaccines against the disease. NIAID already helps fund the ongoing project to sequence the genome of the anthrax bacterium, and investigators supported by NIAID have published two studies in the journal *Nature* that help explain how the anthrax toxin destroys cells.

UC, like other universities, has volunteered assistance and expertise in the fight against bioterrorism. UC's strengths include expertise on anthrax and botulism, and with NIH assistance, UC researchers will redouble their efforts to fight these deadly diseases.

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Publications about federal research funding at UC are produced quarterly by the UCOP Office of Research with assistance from the UCOP Office of University External Affairs.

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