STANFORD UNIVERSITY

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BIO-X
STANFORD UNIVERSITY

Bio-X Bugle

MARCH 2006

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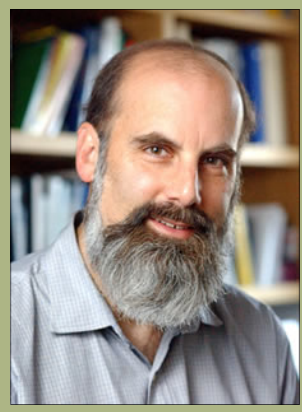

Words from the Bio-X Chair

As always, Bio-X welcomes anyone who would like to join.

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New Center for Cancer Nanotechnology

The NIH and National Cancer Institute (NCI) awarded approximately $20 Million over 5 years to Bio-X affiliate and Clark resident, Sam Gambhir, who will lead a team of researchers from Stanford and other institutions. ***Continued on Page 5.***

BRAIN DAYS!

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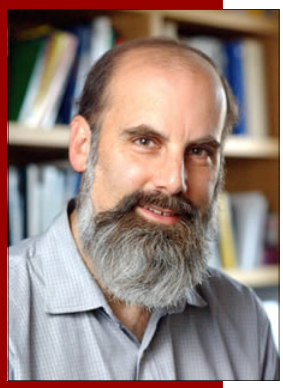
Words from the Executive Chair



Matt Scott

Greetings-

I am the chair of the Bio-X Leadership Council, a group of faculty that is overseeing the development of the Bio-X program. In this issue of the Bio-X Bugle, I would like to provide you with an overview of the Bio-X program and all the events and activities that are going on. You are receiving the Bugle because you are in a research group that is affiliated with the Bio-X program, or because we have reason to believe you may be interested in becoming affiliated. More than 300 faculty in more than 50 Stanford departments have become Bio-X affiliates, and all of their associated students, postdoctoral fellows, and research assistants are considered part of our Bio-X community. *As always, Bio-X welcomes anyone who would like to join.*

Stanford's Bio-X initiative is an effort to accelerate the flow of people & ideas among the fields of science, engineering and clinical medicine

The Bio-X mission:

Bio-X is dedicated to deepening the understanding of life and improving health using tools and insights from many disciplines. We are building a community of excellence that supports education, discovery, and invention. By providing an interdisciplinary environment, research experience, and curriculum, we will educate a new generation of scientific leaders. By forming effective teams, we will produce discoveries beyond those that can be achieved by one discipline alone. By bringing basic science to bear on critical biomedical needs, and fostering collaborations between academia and industry, Bio-X will speed translation of discoveries into important social benefits.

This mission statement was written by the Bio-X Leadership Council, which presently includes: Harvey Cohen (Pediatrics), Martha Cyert (Biological Sciences), Scott Delp (Bioengineering, Mechanical Engineering), Mark Davis (Immunology & Microbiology), Sam Gambhir (Radiology), Hank Greely (Law), Charles Kruger, Deputy Chair, Michael Levitt (Structural Biology), Michael Longaker (Surgery), Teresa Meng (Electrical Engineering), Matthew Scott (Developmental Biology, Genetics, Bioengineering), Chair, Brian Wandell (Psychology, Electrical Engineering), Paul Yock (Cardiovascular Medicine, Bioengineering), Richard Zare (Chemistry). Feel free to contact any of these Council members with your ideas about Bio-X.

BIO-X BUGLE
WINTER 2005

BIO-X
STANFORD UNIVERSITY

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The Leadership Council has identified four goals that encompass key areas of Bio-X science and technology. These will be given special emphasis in grant programs and in shared spaces in the Clark Center. Naturally no four goals can encompass all the work being done by more than 300 Bio-X faculty and their colleagues, and the Bio-X grant programs will continue to support the most creative work that emerges in the applications. The Leadership Council is organizing its planning process for educational and research events around the four goals, which are:

Imaging and Simulating Life from Molecules to Man

Restoring the Health of Cells and Tissues

Decoding the Genetics of Health and Disease

Designing Therapeutic Devices and Molecular Machines

To promote successful interdisciplinary research we are using several approaches:

1. We are sponsoring a large number of events that bring people from different fields of science together for meaningful teaching and discourse.

2. We are offering incentive grants that will reward people who propose and perform creative projects that bridge fields.

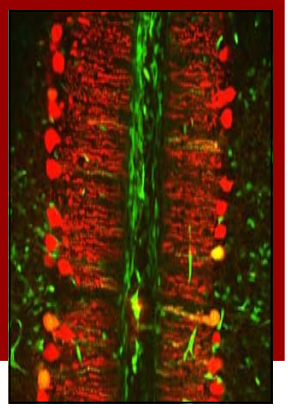
3. We are offering Bio-X graduate fellowships that provide incentives to graduate students to choose thesis research that spans fields in order to solve scientific problems that could not otherwise be successfully addressed.

4. We have awarded Bio-X postdoctoral fellowships to provide incentives for team building between Clark Center faculty and faculty outside Clark.

5. We have assembled an unprecedented blend and range of science and technology in the Clark Center, a building that serves as a focal point for the Bio-X program.

To learn more about the Bio-X Program, visit: http://biox.stanford.edu

Bio-X extends all over campus, a reflection of the reality that no one building can possibly encompass the range of science and technology that is needed to solve today's fascinating biological challenges. Physics, chemistry, many types of engineering, computer science, statistics, mathematics, law, ethics, and all the clinical fields all connect to each other through the common language of biology. That is, however, easily said and not so easy to do. People in each field have their own ways of thinking, converse in specialized language, and measure progress in particular ways. For students, and perhaps even more for faculty, it is challenging to move between fields. A central goal for Bio-X must therefore be to increase the opportunities for mutual education. Biologists must learn about the remarkable capabilities of engineers in order to conceive appropriate applications of those skills. Physicists must learn where their skills might be best applied to biological systems.



The Clark Center is having a powerful community-building effect, bringing together people in different fields. Recent new faculty recruitments in several departments (Biological Sciences, Applied Physics, Radiology, Bioengineering) are filling the building. More than 550 people now work in the Clark Center. They are connected to 25 Stanford departments. 37 faculty are resident in the building; several more will be recruited to fill the remaining space. The new Department of Bioengineering occupies about a quarter of the Clark Center; the department will eventually move to its own building in order to reach the size it needs to be to serve the large number of students interested in this field.

Most importantly the Clark Center is becoming a community center for science. Hundreds of meetings are held there each year, and most of those meetings involve people from all over campus. Shared facilities, such as the Microfluidics Foundry, the Imaging Center, and shared "hotel" spaces are locations where you may encounter people you would not otherwise see. The Linx restaurant and the Peets coffee bar provide additional bait to draw in visitors. The family-style tables are designed to promote chance encounters. We would be happy to hear of any projects that have started after such meetings.

The heart of our university's work is the education of students. Many undergraduate students are doing research in Clark Center labs. A new organization, BioNexus, is bringing together Bio-X graduate students and postdoctoral fellows to bridge fields, help with career guidance, and sponsor scientific and social events. You can join BioNexus by contacting Afsheen Afshar <afsheen@stanford.edu>.

Bio-X Events!

We are organizing special events that should help people who want to learn about science other than their own.

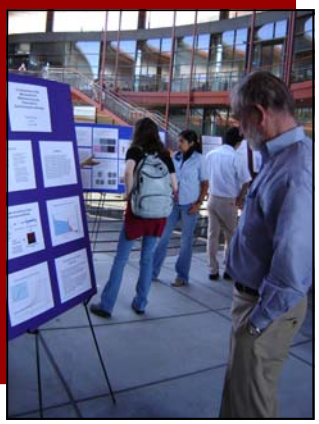
In November Bio-X together with the Program in Regenerative Medicine is hosting a distinguished group of speakers for a Symposium on Regenerative Medicine. The program is posted on the Bio-X website <http://www.stanford.edu/group/biox/news/index.html>.

We are continuing our series of "Talks in English" with three more speakers scheduled to speak in March, April and May. The idea behind these talks is to present speakers who are skilled teachers, who will convey the important ideas in their field in largely jargon-free presentations. A second goal is for the speakers to identify the obstacles to progress in their field that might be overcome with help from other fields—perhaps from someone in the audience.

Words from the Executive Chair

We are beginning a series of "Department Days". These will be afternoon poster sessions in the Clark Center. Two or three departments will participate each time. Researchers from each department will present highlights of department work as posters, and the whole Bio-X community will be invited to come and learn what is going on in those departments. Music and food will accompany the posters. Let us know if you'd like your department to join one of these gatherings. Last year we had a successful Bio-X Kids' Day at the Clark Center. Bio-X community people were invited to bring their children for a day of fun science experiments and demonstrations. The event attracted well over a hundred children, and we hope that some of them will go on to be scientists or at least be among those who appreciate science. This year we will repeat the event, on June 16. Bring your kids!

Through the Interdisciplinary Initiatives Program (IIP), under the direction of Harvey Cohen, Professor of Pediatrics, Bio-X stimulates innovative interdisciplinary research



Grants Programs Continuing!

Everyone who is affiliated with Bio-X is too busy....aren't you! In the face of so many demands it is hard to find time to explore partnerships with people in other fields. The idea of the Bio-X incentive programs is to reward in the most concrete ways possible the boldness of researchers and educators who initiate and carry out interdisciplinary research.

FIRST:

The Interdisciplinary Initiatives Program (IIP) has awarded forty grants during the past five years, totaling about $6 million. This has been funded with gift funds provided by the university and we are particularly grateful for this support from President John Hennessy. The grants are awarded to Stanford faculty in competitions that are open to all Bio-X affiliates; in the past about one-third of the applications have been funded. The IIP judging committee, chaired by Prof. Harvey Cohen (Chair of the Department of Pediatrics), looks for distinctive interdisciplinary work, new directions, educational value, and the potential for major discoveries and inventions. This year we will have a third competition, again for about twenty grants, funded by the President and by Bio-X gift funds. The IIP grants are seed grants intended to bring together people who are doing new and often risky work. No renewals are allowed, though of course faculty can apply for support for different projects. Success is measured by scientific progress, and also by subsequent funding obtained from external agencies. So far more than $65 million in external grants have been awarded to continue projects begun with Bio-X seed grants.

And SECOND:

Bio-X Graduate Fellowships are awarded, in competitions, to ten graduate students each year. The idea behind these fellowships, which are mostly awarded to second and third year students, is to provide an incentive to do more daring interdisciplinary projects. When graduate students arrive at Stanford, they have the opportunity to pursue a wide range of projects, and we believe that the existence of Bio-X fellowships will spur increased interest in thesis research that bridges fields. We expect that students with this type of experience will be much in demand in academia and industry. The awardees often have dual or multiple mentors, from different fields. The Bio-X Leadership Council judges the competitions. The fellowships were made possible by a generous gift from an anonymous donor. Twenty Bio-X Fellowships have already been awarded in the first two rounds. Their science covers an amazing range of ground <http://www.stanford.edu/group/biox/grant/fellowships.html> The fellowships provide most of the costs of tuition and stipend for three years. This year the due date for applications is April 3, 2006. See the website <http://www.stanford.edu/group/biox/grant/fellowships.html> for details.

THIRD:

A new Travel Grant program will be announced to supplement travel costs for graduate students giving oral presentations at scientific conferences. Look for details soon on the **Bio-X** website: <http://www.stanford.edu/group/biox/>

Speaking for the Bio-X Leadership Council, and for the Bio-X Executive Committee, I hope that this overview has been helpful to you. In the dynamic atmosphere of Stanford, with so many programs, clarification of the current status and goals of Bio-X should help to guide you in thinking about how the program may be of benefit to you. We welcome your ideas about how to do better. Interdisciplinary education and science is especially well suited to the Stanford campus, with its seven Schools in immediate proximity, but overcoming traditional separations is nonetheless challenging. I am grateful to all those who are helping, a large group indeed.

Sincerely yours,

Matthew Scott

Cancer-Nano Center to start at Clark

Sam Gambhir

There are over 560,000 deaths from cancer each year in the United States. Treatment for cancer is both expensive and difficult partly because of our inability to accurately determine the patient's response. Physicians often resort to using multiple treatment methods—chemotherapy, radiation, and surgery—to ensure that at least one may reduce or eliminate the diseased tissue. As over half a trillion dollars are lost each year on ineffective therapies, there is an obvious need for improved post-treatment diagnostics.

The NIH and National Cancer Institute (NCI) <http://nano.cancer.gov/funding/nanotech_centers_of_excellence.asp> have awarded $20 Million over 5 years to a team of researchers led by Sam Gambhir, Director of the Molecular Imaging Program at Stanford (MIPS) <http://mips.stanford.edu>, Professor of Radiology/Bioengineering and **Bio-X** affiliate. Researchers from three universities (Stanford, UCLA and UT-Austin), two companies (GE and Intel), and two non-profits (Fred Hutchinson and Cedars Sinai) will develop tools and methods that will determine the effectiveness of anti-cancer therapies for patients. This award demonstrates the commitment of NIH to train and support interdisciplinary research and confirms the vision of **Bio-X** to facilitate "team science." Faculty from all schools—Humanities & Sciences, Engineering, and Medicine—are in collaboration to develop and use nanotechnology in the evaluation of cancer therapeutics. "This grant brings together several **Bio-X** faculty including folks in Engineering and Chemistry and is a great example of Bio-X at work," shared Sam Gambhir.

Nanoparticles and nanotubes are just two functional technologies that Gambhir and the team of more than 15 research labs will use to determine the therapeutic response of cancer patients by testing tissue and blood samples from the body. A major aspect of the award will be testing the therapeutic effect of cancer therapy by imaging tissue *in vivo*. In this case, nanoparticles modified to target cancerous cells would be injected into the body and imaging systems would reveal the location of the diseased tissue. The *ex vivo* sampling of blood is important for identifying the presence of cancer in the body, however, it cannot identify specific locations of aberrant cells. By taking many approaches to identify how cancerous tissue responds to anti-cancer therapies, Gambhir's consortium hopes to find the most effective methods quickly and definitively.

Materials Science professor Shan Wang will develop a chip that uses magnetic nanoparticles to tag and isolate key cancer markers in the blood. The hope is that by teaming with cancer biologists, key clinical challenges will be overcome rapidly to produce diagnostics that may be tested in clinical environments within a few years. Without broad interdisciplinary support, such work might take years longer, or may not even be possible. Engineers developing diagnostic tools in the lab typically have limited access to blood samples from cancer patients, and cancer biologists are unlikely candidates to synthesize magnetic nanoparticles. By bringing these two groups together, each lab can focus on their area of expertise and apply it to something outside of their traditional area of training. The Center of Cancer Nanotechnology Excellence is focused on measuring therapeutic response to cancer treatment. The center will bridge the gap between nanotechnology and clinical applications for cancer treatment and diagnosis. The scope of this award is larger than any other awarded by NIH and demonstrates a commitment to support "team science" to address such challenging problems. It is the "team science" approach that **Bio-X** hopes to facilitate and grow both now and in years to come.

Bio-X Research Themes:

Biocomputation

Biodesign

Biomedical Imaging

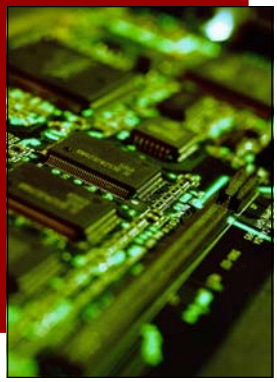
Brain & Behaviour

Cell/Molec. Engineering

Chemical Biology

Genomics & Proteomics

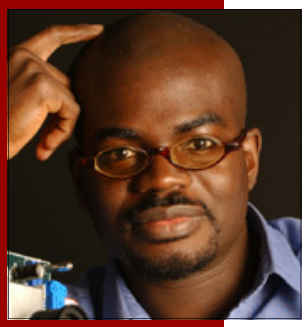
Regenerative Medicine



Stanford Participants in CCNE

Sajiv Sam Gambhir - Radiology
Shawn Chen - Radiology
Richard Chin - Geballe Lab
Hongjie Dai - Chemistry
Dean Felsher - Medicine-Oncology
Samira Guccione - Radiology
Michael Kelly - Material Science & Eng.
Ed Myers - Electrical Engineering
Yohio Nishi - Electrical Engineering
Garry Nolan - Mircrobiology & Immunology
David Paik - Radiology
Sylvia Plevritis - Radiology
Jianghong Rao - Radiology
Meike Schipper - Radiology
Robert Sinclair - Materials Science & Eng.
Sandy Srinivas - Oncology
Mary Tang - Electrical Engineering
Robert Tibshirani - Health & Research Policy
Paul Utz - Mecidicine
Shan Wang - Materials Science & Eng.
Robert Wilson - Materials Science & Eng.

New Clark Faculty



Kwabena Boahen

The Bio-X Program integrates the creative talents and spirit of Stanford faculty in a way that remodels the landscape of science and technology on the campus

Kwabena Boahen was appointed Associate Professor in Bioengineering in December 2006. He is a bioengineer who is using silicon integrated circuits to understand how neurons compute, linking the seemingly disparate fields of electronics and computer science with neurobiology and medicine.

His lab is currently developing Neurogrid, a specialized hardware platform that will enable the cortex's inner workings to be simulated in detail—something outside the reach of even the fastest supercomputers. Professor Boahen's numerous contributions to the field of neuromorphic engineering include a silicon retina that could be used to give the blind sight and a silicon chip that emulates the way the juvenile brain wires itself up. His scholarship is widely recognized, with over sixty publications to his name, including a cover story in the May 2005 issue of Scientific American.

Making Connections *(Written by Kwabena Boahen)*
Ants can identify their nest-mates by smell, but what if ants from other colonies could fake the scent, how would the ants identify friend or foe then? This is similar to the problem Neurotrope1 solves when it wires up neighboring GanglionCells (silicon neurons in Visiol) to neighboring TectalCells (silicon neurons in Neurotropel).

The electrical charge that TectalCells release is indistinguishable. And all the GanglionCells pick up this same electrical gradient as the charge diffuses across Neurotropel's surface, just like smells diffuse through the air. But, somehow, Neurotropel can tell which GanglionCells are neighbors and which are not.

If the ants used the same strategy as Neurotropel, this is how they would do it. They would synchronize their biological clocks, get them all ticking in unison, before leaving the nest. And they would agree to release the scent only when a tick occurs, doing it on the dot. Then, to identify friend or foe, an ant would wait till its biological clock ticked and whisk its antennae to see if the stranger released the scent at the right time. That is exactly how Neurotropel knows which GangionCells are neighbors: they are active at the same time. Their synchrony arises not from a clock, but from the stimulation pattern Visiol provides as it activates small patches of its GanglionCells at random. Such patterns are generated endogenously by the developing retina, in the womb, well before the eyes open.

Now what if all the ants wanted to congregate at the same forage site, sight unseen? Each ant would whisk its antennae when its clock ticked, but now it would also figure out where the scent was coming from and head of in that direction. This is exactly how Neurotropel connects neighboring GanglionCells need to neighboring TectalCells. The GanglionCells do not only detect the presence of electrical charge; their silicon growth cones tell them the direction in which the charge is more concentrated. By heading in that direction, they home in on the TectalCell that is releasing charge in synchrony. But why is this TectalCell releasing charge at this particular time, exactly when the GanglionCell itself is active? You guessed it! Because it is a friendly: It was activated at the right time because it is connected to the GanglionCell's neighbors!

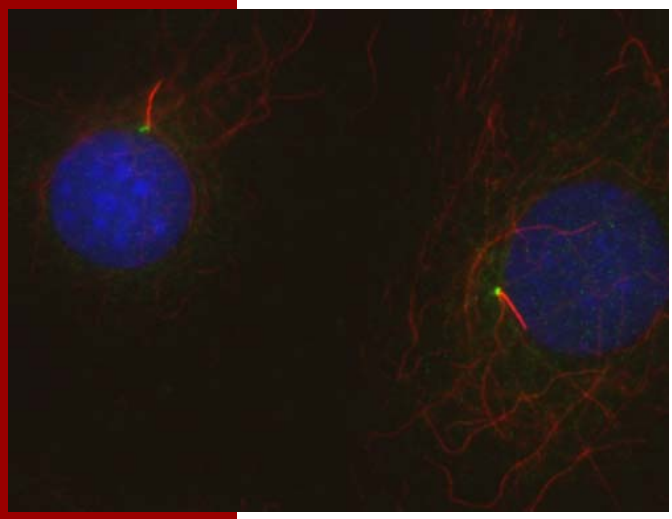
fMRI of Anterior Cingulate Cortex

Vinod Menon

Monitoring the environment for change, allocating attentional resources and deciding on a course of action when changes are detected are critical for survival. A particular region of the brain, the anterior cingulate cortex (ACC), is important in attentional control, and is the focus of a recent study by Prof. Vinod Menon, of the Department of Psychiatry and Behavioral Sciences, **Bio-X** affiliate and recipient of a **Bio-X** IIP grant. Test subjects were given the task of responding to a frequent stimulus, which occurred on 80% of the trials, in one way and an infrequent stimulus, which occurred on 20% of the trials, in another. Both visual and auditory stimuli were tested. The location and timing of the response of the ACC during the tasks was measured using a combination of functional magnetic resonance imaging (fMRI), which provides high spatial resolution, and event-related potentials (ERP), which provide high temporal resolution. The ACC showed increased activity during the infrequent stimulus, whether it was visual or auditory. During infrequent visual stimuli, the ACC showed enhanced connectivity with the primary visual cortex, whereas during auditory stimuli, the connectivity was enhanced with the primary auditory cortex. Biophysical modeling of the ERP time series based on spatial localization provided by fMRI activations show that the ACC first receives a stimulus-mismatch signal from the primary sensory areas and then responds to it with a control signal that is trans-

Menon, Continued on Page 7

Mechanotransducers in Bone cells: Primary Cilia?



Many tissues in the body are known to be sensitive to mechanical loading, but other than a few specialized cells, no one knows how cells in these tissues sense physical stimuli. For example, although endothelial cells in blood vessels, chondrocytes in cartilage, and osteocytes in bone are all mechanically sensitive, none exhibit obvious cellular structures for this purpose.

Christopher Jacobs (Mechanical Engineering) and Tim Stearns (Genetics) believe they may have an explanation for this long-standing mystery: primary cilia. Primay cilia were first described over a century ago, and despite being present in most cell types, no biological function has been identified. Indeed, these slender whip-like cellular appendages, were thought by most to be vestigial. On a flight from San Francisco to Washington, DC when they were randomly assigned adjacent seats, they imagined that primary cilia might act as mechanotranducers in bone cells and devised a pilot research project to find out. Their most recent evidence includes the first picture of primary cilia in bone cells since the 1970's. They also found that without primary cilia, bone cells in culture lose their sensitivity to mechanical loading. Amanda Malone, **Bio-X** Bioengineering Graduate Fellow, presented these results at this year's meeting of the Society for Physical Regulation in Biology and Medicine at Cancun Mexico and received the outstanding student paper award. The cell culture work is ongoing and Sara Temiyasathit (Bioengineering), Joyce Tang (Mechanical Engineering) and Charles Anderson (Genetics) are working together to create a mouse that is missing its primary cilia in bone tissue.

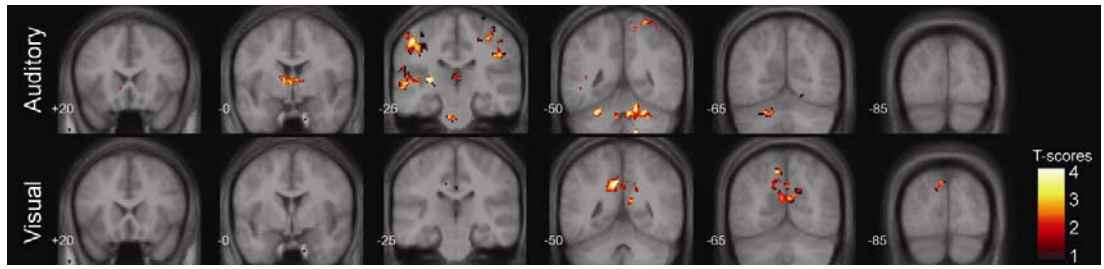
If their hypothesis is correct, the bones of this mouse will not be sensitive to mechanical demands. If this novel molecular mechanism of mechanotransduction is substantiated, it would represent a shift in paradigm and might lead to novel drugs in the fight against osteoporosis and bone loss during space travel.

Bio-X was formed in recognition of the enormous potential for biology, engineering, physics, chemistry, mathematics, and clinical science to join in mutually enriching research projects

fMRI of Anterior Cingulate Cortex

Menon, Continued from Page 6

mitted back to the primary sensory areas as well as other neocortical regions. These findings suggest a model of attentional control based on dynamic bottom-up and top-down interactions between the ACC and primary sensory regions. Such interactions underlie brain mechanisms by which neural activity is amplified in order to favor the selection, maintenance and manipulation of task-relevant information. The combined experimental approach of using fMRI together with ERP is furthering our understanding of the dynamic workings of the human brain.



Brain regions that showed increased stimulus-dependent connectivity with the ACC (Talairach coordinates: x=-4, y=20, z=26) during the auditory (top) and visual (bottom) oddball tasks. Modality-specific effects are observed in both tasks with increased ACC influences on the Heschl's and superior temporal gyri during the auditory task and on the striate cortex during the visual task. Each cluster is significant after correction for multiple spatial comparisons ($p < 0.05$). Activations are shown superposed on group-averaged, spatially normalized, T1-weighted structural images.

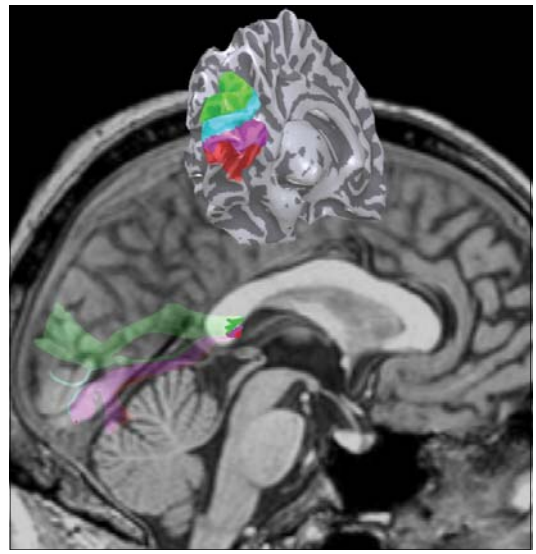
The overarching goal of the Bio-X Program is to assure a broad-based , campus-wide integration of efforts in interdisciplinary teaching and research encompassing the Schools of Engineering, Medicine and Humanities & Sciences

Mapping Across the Human Brain

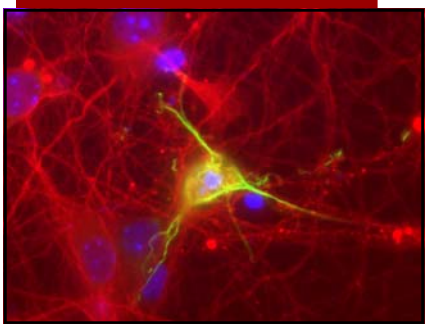
The human brain changes in a variety of ways throughout life. These changes take place at a variety of spatial scales, ranging from modifications of the synaptic connections between individual cells to changes in the large bundles of axons that connect distant brain regions. Healthy development of these pathways during childhood is essential for many cognitive, sensory and social skills. Damage to the connections is the cause of many types of diseases.

Our lab develops computational techniques, based on magnetic resonance imaging data, to measure the pattern of connectivity in the developing human brain. We apply these techniques to a variety of topics. For example, with the cooperation of a group of parents and children, we are making behavioral assessments and measuring the functional and structural development of several brain regions essential for reading development in children between the ages of 7 and 13.

One brain region important for reading is the posterior portion of the pathways that connect the left and right hemispheres: This region is called the splenium of the corpus callosum. Many of the fibers that pass through the splenium connect a set of visually responsive cortical regions, called visual field maps. The integration of the two halves of the visual field via these pathways is an important prerequisite for complex visual tasks, including reading. The upper inset image shows the general location of the visual field maps on the left hemisphere of a human brain (measured using a technique called functional MRI). The background image shows the fiber bundles that connect the right and left visual field maps. These bundles pass through the splenium and continue to the cortical surface in the left occipital lobe. The fiber bundles were estimated using a magnetic resonance imaging method called diffusion tensor imaging. (See: Dougherty et. al. 2005 PNAS; Dougherty et. al. 2005 Annals NYAS; Deutsch et. al. 2005 Cortex.)
Bugle article submitted by Robert Dougherty, Dept of Psychology, **Bio-X affiliate.**



Regulation of Cytoskeletal components



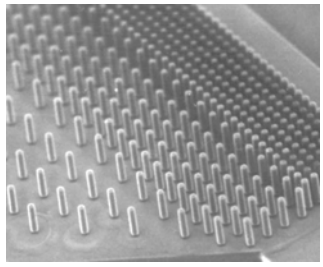
Giant axonal neuropathy (GAN) is a severe and recessive neuropathy affecting both sensory and motor neurons. The aberrant cytoskeletal network in GAN points to the essential role of gigaxonin, the *GAN* gene product, in cytoskeletal organizations and functions. In our study, gigaxonin was identified as a novel cytoskeletal regulator controlling cytoskeletal protein degradations. Loss of gigaxonin's function in GAN could result in toxic cytoskeletal protein accumulations, consequently leading to neuronal cell death. Relieve of the toxicity caused by protein accumulation using interference RNA could significantly improve the survival rate of the deficit neurons. Our study underscores the role of improper regulation of cytoskeletal componenets in human neuropathies.

In fact, abnormal cytoskeletal function or impaired protein degradation system is also the hallmark of several other devastating neurodegenerative disorders including Alzheimer's, Parkinson's, amyotrophic lateral sclerosis (ALS), Charcot–Marie–Tooth disease type 2 (CMT2), and spinal muscular atrophy (SMA). Evidence from spontaneous mutant and genetically manipulated animal models indicates that at least some of the neurodegenerative disorders in humans may be caused by alterations in cytoskeletal components and abnormal protein degradation pathways. Elucidating the pathogenesis of GAN may represent a central step towards understanding molecular mechanisms underlying other human neurodegenerative diseases. (See: E. Allen, J. Ding, W. Wang, S. Pramanik, J. Chou, V. Yau, Y. Yang; Nature. 2005 Nov 10; 438(7065):224-8.)
Bugle article submitted by Yanmin Yang, Dept. of Neurology & Neurological Sciences, **Bio-X affiliate.**

Optical Retinal Prosthesis

Daniel Palanker

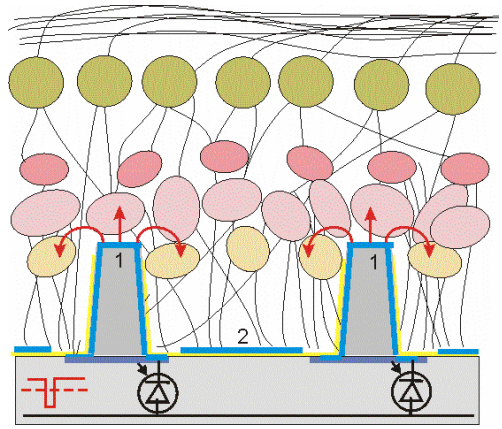
Vision loss due to retinal diseases such as age-related macular degeneration (AMD) and retinitis pigmentosa (RP) has the potential for treatment using electronic prosthetics. Although the cells that are responsible for converting light into neural signaling (the photoreceptor layer) degenerate, the neural circuitry that processes these images in the retina still retains some function. The goal of Daniel Palanker, **Bio-X** affiliate and IIP grant recipient, and his research group is to create a prosthetic that will bypass the diseased layer of tissue and "talk" to the remaining healthy layers of cells in the retina to restore some sight to both AMD and RP patients.



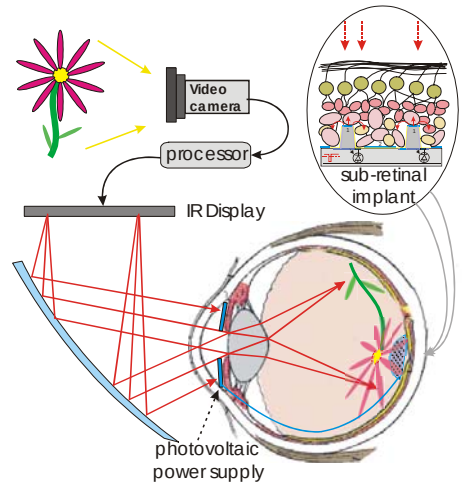
Array of pillars with various spacing: 60, 35 and 20 μm center to center

Current retinal prosthetic system includes a head-mounted camera, portable computer for image processing and near-infrared goggles that optically transmit the processed image to the pixels in the patient's retinal implant. The photosensitive pixels convert pulses of IR light into biphasic pulses of electric current using intraocular power supply. The number of pixels that communicate with the inner retina correspond to the spatial resolution that would be possible using the retinal prosthetic. For high visual acuity a very close proximity of electrodes to the target cells is required.

For example, 20/80 visual acuity would require that cells not be farther than about 10 μm from the electrode. Palanker and coworkers designed two types of arrays that encourage migration and growth of the cells into close proximity of the electrodes. The cells retain their connection to the retina, and the migration allows for intimate contact between the cells and the electrodes along the entire chip.



3-dimentional array activated by powered photodiodes.



Bio-X "Talks in English" (T.I.E) Introducing a broad range of scientific research in the Bio-X community through jargon-free lectures and discussion. http://biox.stanford.edu

Opportunities in Medtech at Career Fair

LinX was home to the first Med-Tech Job Fair, held February 23 from 4:00pm—7:00pm. Over 200 students, postdocs, and researchers visited with companies in the Medical Device Technology industry. The event was presented by the Career Development Center, Biodesign, **Bio-X**, Bioengineering and the School of Medicine Career Center.

Abbott Labs
Accuray, Inc.
Acumen Medical
Alexza Pharmaceuticals, Inc.
Boston Scientific
INDEC Medical Systems
Johnson & Johnson Co. ~ Cordis
Johnson & Johnson Co. ~LifeScan, Inc.
Kerberos Proximal Solutions
Lab Pros
Lunar Design, Inc.
Manpower
Medtronic
Novo Nordisk Device Technologies, Inc.
VNUS Medical Technologies
W.L. Gore and Associates

Palo Alto students excited by Brain Days

Bio-X "Frontiers in Interdisciplinary Biosciences" seminar series - An introduction to cutting-edge research involving interdisciplinary approaches to biosciences and biotechnology.

Graduate students from the Neurosciences program are visiting Palo Alto middle schools to share their knowledge about the brain and how it works. As part of the seventh grade curriculum in Palo Alto, students spend time learning about the nervous system. After learning the location of the parietal lobe (the top, center part of the brain), the function of the cerebellum, and some diseases that occur in the brain, the students are treated to a hands-on demonstration with human and animal brains.

A typical visit begins as graduate students introduce themselves to the seventh grade science class and explain their research. The students listen attentively, and respond when asked, "What does your brain do for you?"

"It tells us whether we are hungry or thirsty."

"The cerebellum helps you balance."

"It stores information."

"It helps you not die...if you didn't have a brain, you'd be dead."

Listing the information on the board, the graduate student, Dan Wetmore in this case, shifts the discussion to what can go wrong with the brain. Diseases such as Parkinson's and Alzheimer's are immediately mentioned. When one student offers "concussions" as a type of damage, Bill Newsome, Professor of Neurosciences, Clark faculty and **Bio-X** affiliate, asks for the typical ways that kids suffer from a concussion. Although not a top cause of concussions, one response was memorable: "For me, it's running into a door."

Grad Student Trent Watkins talks about the brain specimen.

The first time that Bill Newsome shared about his research on brains with a seventh grade class, his son was part of the audience. Since that time (his son is now 25), Bill has built up a program in which neurosciences graduate students make their way into every seventh grade science class in Palo Alto. It is a chance for kids to encounter science on new level and for graduate students to experience teaching as most have not during their PhD careers.

After the discussion about the brain, three stations await the students—with opportunities to hold a human brain, to examine the cross section of the brain, and to compare the human brain to those of other animals, such as mice, monkeys or fish. This experience is what the students await and will remember for years to come. As the students touch and feel the typically inaccessible tissues, they ask and respond to questions that demonstrate their curiosity about what is and isn't known about the brain. This is a perfect opportunity to explain how scientific research is constantly revealing new insights about the inner workings of the brain and in turn spark an interest that may lead to some of our future graduate students in the sciences.

Graduate Student Scott Owen and Professor Bill Newsome prepare to talk about various brain specimens with 7th graders at Terman Middle School.

Kids Day at Clark

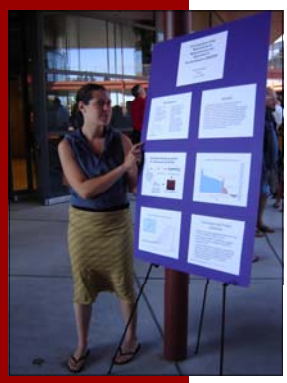
June 16th, 2006, 1:30 - 4:00pm

Do you love science and love sharing your knowledge about science with kids?

Do you have ideas for hands-on demonstrations to share with kids?

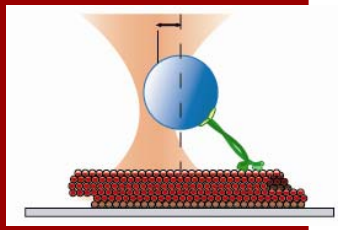
*Please contact Jill Sakata, **Bio-X** Education and Fellowship Manager <jsakata@stanford.edu> for opportunities to help at Kids Day and other events.*

Student Announcements



To receive Bio-X email, including seminar reminders and news: Enter the following command as a single line in the body of your email: subscribe bio-x_program

Then mail the command to majordomo@lists.stanford.edu



Bio-X Graduate Student Fellowships

The **Bio-X** Leadership Council is pleased to announce the competition for **Bio-X** Graduate Student Fellowships, and a series of endowed **Bio-X** Fellowships. The **Bio-X** Graduate Student Fellowships are the generous gift of an anonymous donor who is helping Stanford strengthen graduate training in interdisciplinary biosciences and so spur important new advances in science and engineering. In addition, three endowed fellowships will be awarded. Please find additional information at http://www.stanford.edu/group/biox/grant/fellowships.html
Questions? Contact Jill Sakata, **Bio-X** Education and Fellowship Manager. <jsakata@stanford.edu> Applications will be accepted until April 3, 2006 for fellowships that will begin in the fall quarter of 2006.

Bio-X Poster Printer now available

Students, postdocs and researchers interested in printing posters for scientific conferences should contact Tanya Raschke, **Bio-X** and Clark IT Manager <tanya.raschke@stanford.edu>.

Bio-X Protein Engineering and Biophysics Workshop

Bring your lunch and join us for the next workshop, to be led by Megan Valentine, a postdoctoral fellow in the Block Lab.

March 22, noon—1pm, S360
An overview of single-molecule biophysical methods
Megan Valentine, PhD

This workshop series serves as a scientific resource for students and post-docs affiliated with **Bio-X** to aid research and career development. The format is based on interactive participation with a focus on the interests of students and post-docs. Topics are chosen to fit the interest of the participants and promote the interdisciplinary mission of the **Bio-X** program. The intended audience is individuals studying the engineering, biophysical, and structural aspects of proteins. Anyone with an interest in these areas is welcome.

Stanford's Education Program for Gifted Youth (EPGY) seeks several experienced doctorate or post-doctorate scholars in bioscience, biotechnology, or related fields to teach a three-week course on Bioscience/Biotechnology to academically-talented high-school students this summer at Stanford.

The EPGY Summer Institutes are three- and four-week programs involving intensive in-depth academic investigations. Students in the program are selected for their ability and interest in the course subject areas; they participate in just one course and enjoy challenging and engaging topics that are not available to them in school. Students for Summer 2006 will be coming from across the U.S. and from around the world. Instructors are given freedom to incorporate their own course ideas, and they are supported by undergraduate and graduate student teaching assistants. Each day consists of two to three hours of class time, plus a three-hour period for individual and small group work dedicated to assignments and projects. For more about the EPGY Summer Institutes, please visit: http://epgy.stanford.edu/summer/institutes.html

Salary range $3300-4000 per course. Interested candidates should send a current resume or CV and a brief cover letter to Dr. Valerie Ross, Director of the EPGY Summer Institutes, Valerie Ross, PhD <varlet@stanford.edu> Questions may be also directed to this address.

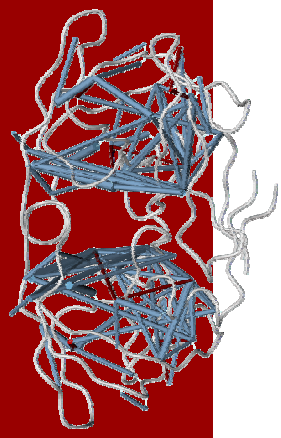
BioNeXus

There's no question that Stanford campus is home to some of the greatest and most innovative minds in the world. But they are not all professors; our fellow students, post-docs, and staff are not only extremely bright, but they are treasure troves of useful information. Everyone has felt that they are re-inventing the wheel at one point in their education. Wouldn't it be great if you could simply send an email to, or even have lunch with, a veritable expert in the field and engage in a useful discussion about your specific interests? The current alternative of endless Googling is often fruitless and tiresome.

A group of graduate students, postdocs, and others affiliated with BioX have banded together in order to try to take advantage of the great unused asset on campus: each other. Their new group, BioNeXus, is devoted to promoting and facilitating a community of interdisciplinary research and recreation here in BioX. They aim to increase the number of professional and personal relationships in the department not only to help us learn from each other, but also to help make us a more cohesive group of researchers.

But how? Everyone on campus is already so busy, and most people simply do not have time to try to meet new people. For this reason, BioNeXus will offer several opportunities this quarter. They will only continue the popular Happy Hours as well as sponsor some more intimate lunches and dinners. They will also be inviting several speakers to campus, including those from various fields of industry, to talk about career options after Stanford. Finally, they'll sponsor private wine and cheese events with invited faculty so you can meet luminaries outside of your immediate field. If you're excited about learning more about your distinguished colleagues, then try to check one of these out. Please visit their website, bionexus.stanford.edu, or email the president, Afsheen Afshar <afsheen@stanford.edu> for more information.

Upcoming Events



Bio-X at Stanford...

To Discover...

To Invent...

To Educate...

Bio-X Annual Symposium—Regenerating Life
November 9-11, 2006

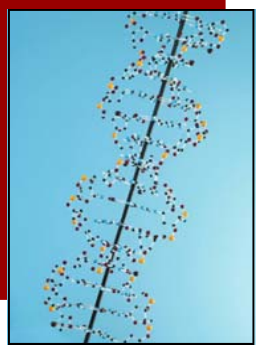
This year **Bio-X** has teamed up with Stanford's Program in Regenerative Medicine to hold a symposium entitled, "Regenerating Life." The goal of the next symposium is to educate students and scientists from different disciplines about the rapidly advancing field of regenerative medicine. Different aspects of regeneration science will be presented by a series of experts and innovators from around the world. Speakers will be asked to give a twenty-five minute lecture on new developments in their area of research, with sufficient introduction and context to help people trained in other fields to appreciate the research. Lectures and discussions will be videotaped for future reference for students.

Our symposium is planned for November 9-11th, 2006. Talks will be presented during the days of the 9th and 10th. During the symposium there will be poster sessions where Stanford graduate students and postdoctoral fellows will present their research. On Nov 11 we may hold one or more workshops, as was done successfully last year.

Bio-X Frontiers in Interdisciplinary Biosciences
Spring Quarter

The "Frontiers in Interdisciplinary Biosciences" seminar series provides an introduction to cutting-edge research involving interdisciplinary approaches to bioscience and biotechnology. The series is organized and sponsored by the Stanford Bio-X Program.

Three seminars each quarter address a broad set of scientific and technical themes related to interdisciplinary approaches to important issues in bioengineering, medicine, and the chemical, physical and biological sciences. Further details: <http://www.stanford.edu/group/biox/courses/459.html>



April 13, 2006
Daniel Chiu, University of Washington
"Nanoscale methodologies for probing synaptic function"

May 4, 2006
Ron Weiss, Princeton University
"Engineering synthetic multicellular systems"

May 25, 2006
Jennifer Cochran, Stanford University
"Engineering proteins for therapeutic applications"

Clark Center Auditorium, 4:15pm

Bio-X "Talks in English" (T.I.E.)

Introducing you to a broad range of scientific research in the Bio-X community through jargon-free lectures and discussion.

March 7th, 2006
Professor Sam Gambhir
Department of Radiology
(Clark Auditorium)

April 13th, 2006
Professor Lucy Shapiro
Department of Developmental Biology
(Clark, Seminar Room: S360)

May 17th, 2006
Professor Stephen Quake
Department of Bioengineering
(Clark, Seminar Room: S360)

Talks will start at 4:00pm followed by refreshments at 5:30pm.

Bio-X Explorers Series

Professor Jean-Claude Latombe

Department of Computer Science

Exploring...

Kyrgyzstan, Tajikistan, Uzbekistan and Xinjiang

April 26, 2006
Clark, Seminar Room: S361, 4:00pm

Go-With-the-Flow 5K Fun Run
May 2006
Zarins Vascular Research Lab/**Bio-X** supported

Come out for a run around campus and bring your lab!
Further details available soon at:
<http://171.65.102.190/gowithflow2006/>

Kid's Day at Clark
June 16th, 2006
1:30—4:00pm
Clark Center Courtyard