AMHERST COLLEGE

Expanding the Reach of Neuroscience

Neuroscience is a highly specialized area of biology, but it's also the perfect subject for a liberal arts education, says Amherst College's Stephen A. George.

"Neuroscience brings together almost all the sciences: you have to understand quite a bit about biology, chemistry, physics, math, and psychology. It's a great vehicle for science education," George says. It's also the stuff of stimulating questions: How do we learn? What causes schizophrenia? Why can a person remember their fifth birthday party, but not their sister's phone number?

That mix of interesting questions and broad science is why Amherst College is using a $1.3 million science education grant from HHMI to bring the wonders of neuroscience to everyone from second-graders to undergraduates to high-school teachers. Neuroscience is a special strength of the Massachusetts-based college. Over the last three decades, Amherst has trained more than 350 neuroscience majors.

During the school year, the school uses part of its HHMI grant money to welcome more than 100 K-12 students who visit Amherst's neuroscience laboratories on field trips or whose class gets a visit from a neuroscience faculty member. The Amherst faculty and staff aim to make each trip special for their budding "visiting neuroscientists" by tailoring the activities to each group's particular interests. Art-school students, for example, may spend several hours touching, learning about, and drawing sketches of sheep brains, a standard neuroanatomy teaching tool. Second-graders might don electrodes, clench their fists, and watch as the electrical pulses from muscle activity make jagged patterns on a viewing screen.

Amherst was the first undergraduate institution to offer a neuroscience major in 1973. But the field has changed constantly since then, and truly exploded over the past 10 years. One of the growth areas has been molecular neurobiology: studying the genes and proteins that are expressed in nerve cells and how they relate to learning, disease, and gender differences in the brain, among other things.

"We can work on these questions in an indirect sense, but we don't have a molecular genetics expert," George said. Using HHMI grant funds, the school will hire a tenure-track molecular neurobiologist, who will teach a new course and supplement what's taught in existing courses. The new faculty member will also expand the types of research opportunities open to undergraduates.

Amherst also will use grant funds to offer summer research fellowships to undergraduates, start a weekly journal club where students will read the latest research in their area of study, and start a program where Amherst undergraduates can share ideas and hypotheses with students from nearby Hampshire, Mount Holyoke, and Smith colleges.

BARNARD COLLEGE

Tobacco Hornworm Is the Star of Integrated Research

Many undergraduate biology experiments, while useful for demonstrating principles, are more cookbook than cutting edge. Using part of a $1.5 million HHMI science education grant, Barnard College will turn some of its biology lab courses into a setting for ground-breaking research on a pest that attacks tomatoes and potatoes.

The tobacco hornworm, *Manduca sexta*, will be the focus of a four-year research-based curriculum in functional genomics. A hardy organism with a short life cycle, the hornworm—the larva of the Carolina sphinx moth—is a model commonly used to study biological questions, especially in neuroscience. It is an agricultural pest that feeds on tomatoes, potatoes, and tobacco leaves. Barnard faculty member John Glendinning has studied M. sexta for years, focusing on the worm's senses of taste and smell.

The worm with be the thread that weaves together the series of courses. A first-year biology course at Barnard will introduce students to the hornworm; the course's laboratory component will include behavioral experiments, such as investigating which foods it likes and dislikes. In a lab for a second-year course in genetics, students will amplify and sequence hornworm genes that code for taste and smell receptors.

In a third-year molecular biology lab, students will investigate the role of these hornworm genes in its sense of smell by studying gene expression levels and patterns. They also will block the expression of specific receptors for taste or smell. Students in a fourth-year animal physiology lab will then study the effects of the blocked receptors on the worm's senses of taste and smell: does blocking the products of certain receptor genes change a hornworm's preferences for certain scents or tastes?

None of the planned experiments has been done before, said Paul E. Hertz, professor of biological sciences and program director of the HHMI grant. "This will enable our students to do cutting-edge research in a lab class context. The experiments could lead to publication, with every student as an author."

Though the four courses can be taken in sequence as part of the functional genomics curriculum, students who take only one will still benefit, Hertz said. "The contribution this curriculum will make to each course will stand alone, but a student who takes all of the courses will benefit from seeing the linkages between disciplines."

BOWDOIN COLLEGE

Post-Graduate Year Caps Off Student Research Career

Independent undergraduate research often grinds to a halt when graduating seniors hand off their successful research projects to inexperienced peers, just when the seniors could begin making important discoveries.

To help fix that problem, Bowdoin College is using part of a new HHMI grant to provide two seniors with the opportunity to spend a year continuing their research at Bowdoin after they graduate. The goal is to keep promising young researchers engaged, keep their projects moving forward, and hopefully produce work that merits publication in a peer-reviewed journal. These graduates will also mentor younger researchers to provide another level of leadership in the laboratory.

"Most Bowdoin [science] graduates don't go directly to medical school or graduate school upon graduation. They often work as research assistants for a year or two," says Patsy S. Dickinson, professor of natural sciences and program director for the $1.1 million HHMI grant at the Brunswick, Maine, college. "We wanted to give some students who have made significant progress on their undergraduate research the opportunity to work here at Bowdoin. In the process they will engage in a much higher level in their thinking and perhaps get a publication out of it."

The focus on creating these two post-graduate research positions is part of a larger emphasis on student research. "The single biggest thing we are doing with this grant is increasing the number of students who are doing research," Dickinson says.

Bowdoin has received three previous grants from HHMI, which have helped support a thriving community of students pursuing research in the biological sciences. This is especially evident during the summer months, when nearly 60 students are on campus working as "apprentices" to faculty investigators.

In addition to creating post-graduate research positions, Bowdoin will use its new HHMI grant to try to increase the number of people traditionally underrepresented in the sciences, women, and first-generation college students who choose to participate in a pre-freshman science immersion program. Bowdoin is focusing on these groups because they are traditionally underrepresented in the sciences. The school will also open its research laboratories to 10 students from underrepresented groups as part of a work-study program.

BRYN MAWR COLLEGE

Teachers Old and New Get Exposure to Science

From kindergarten to senior year in high school, students are exposed to science, whether they are watching chicks hatch or doing research on acid rain. Yet many of their teachers have never been in a lab, and most don't have solid science backgrounds. Bryn Mawr College is using much of its $1.2 million HHMI science education grant to engage teachers how science really works.

For more than 15 years, Bryn Mawr has been bringing precollege teachers to campus for two weeks to attend classes that stress the scientific method and collaborative learning. The classes emphasize exploration and uncertainty. Paul Grobstein, a professor of biology at Bryn Mawr, said the program gets "teachers comfortable with the idea of being wrong" and helps them understand that scientists constantly reexamine their view of how the world works based on the results of experiments. The success of the program has led to a collaboration with the faculty at nearby Haverford College, who will run their own summer institute modeled after the Bryn Mawr program.

Besides its commitment to improving the science knowledge of established teachers, the school is looking out for promising students who might one day become teachers themselves. In a collaborative program with nearby Haverford College, Bryn Mawr offers secondary teaching certifications to students studying math, biology, chemistry, and physics. To ensure that promising science and math majors can become certified, Bryn Mawr is funding two year-long fellowships for recent graduates who need a fifth year of study to become certified.

"We try to stress a broad range of careers for our students, with science education being a key component," said Peter D. Brodfuehrer, a professor of biology and program director for the grant. "Fellowships for talented undergrads to get teaching certification may help stronger students with science and math backgrounds consider education as a worthy professional goal."

The school is also continuing a research program that gives five college students the chance to conduct laboratory research at medical centers, universities, or government facilities during the summer in the Philadelphia area or worldwide. The program offers two fellowships for student assistants in the summer program for K-12 teachers.

Another teaching tool at Bryn Mawr is its Serendip website (http://serendip.brynmawr.edu), which is one of the college's many outreach efforts in science education and serves as a resource for teachers in the summer program. The website has a new design that allows anyone to post comments or add information, Brodfuehrer said. "I think this format will make it more valuable for teachers and students. Some faculty have their entire courses on the site, and the students put all of their work on it, so anyone in the world can comment on what students are doing."

CALIFORNIA STATE UNIVERSITY-FULLERTON

Reaching Three Levels of Students through Biomedicine

With 35,000 students, California State University-Fullerton the largest college in California and serves a highly diverse population: nearly one-third of its students were born outside the United States, and more than 50 percent come from families where neither parent graduated from college.

This diverse community brings a unique set of challenges, which Cal State Fullerton hopes to address by creating a unique, three-tiered approach to student research. The college actively encourages its undergraduates to seek firsthand research experience, but financial support for these positions has been extremely limited. Many talented students must devote significant portions of their time to off-campus jobs, and are left without resources to pursue the inquiry-based science that could launch their careers. Using its first-time $1.2 million HHMI grant, Fullerton will expand the student research community on its campus, drawing more Fullerton undergraduates into the labs, as well as students from area high schools and community colleges.

The high school component will focus on 16 Orange County teachers, each with two of their students. The teacher-student teams will come to campus for five weeks in the summer to do research in the lab of a Cal State Fullerton faculty member. The next school year, these teacher-student teams, as well as some other high school students, will come to campus twice a year for two weekend-long research projects that focus on interdisciplinary, real world science issues.

"We hope this part of the program will gradually build a community of research interest at the high school level," said Maria C. Linder, professor of chemistry and biochemistry and program director of the HHMI grant. "Teachers will get credit for the program. It's a new venture, and depending on how it goes, we may expand it."

At the community college level, Cal State Fullerton will recruit students to participate in its summer research program. The community college students, along with Fullerton undergraduates, will spend 10 weeks on campus doing research. During the academic year, a total of 64 community college students over 4 years of the grant will join the high school students and teachers for weekend research programs.

To reach its own students, the school will choose four undergraduates each year for an intensive, two-year program that involves mentored laboratory research, weekly workshops, and poster presentations at local and national meetings. Each scholar will write a senior research thesis. The program will focus on motivated students who have overcome adversity and are committed to earning a graduate or professional degree in the biomedical sciences.

"I'm excited about the integrated nature of the projects," Linder said. "The objective for us and for HHMI is to recruit more students into the biomedical sciences as researchers, and we're trying to attack this in three or four ways at the same time."

CALVIN COLLEGE

The Future of Biology: Do the Math

The old joke was that biologists were the bright kids in science who couldn't do the math. Today no research biologist is safe from the growing importance of quantification and mathematical modeling, as the boundaries grow thinner between the traditional scientific disciplines of biology, chemistry, physics, computer science, and mathematics. With a new $1.1 million HHMI grant, science at Calvin College in Grand Rapids, Mich., should have an even more wide open future.

"Our big tough problems in biology today require multiple approaches. No one person embodies all the different kinds of expertise needed to solve them," says David H. DeHeer, the chair of Calvin's biology department. "To be a top-notch scientist, you need to work with others and be collaborative in your thinking in order to integrate expertise from multiple disciplines. This will be an important part of the training for a new generation of scientists."

The new HHMI grant will accelerate this necessary blurring of boundaries between biology, mathematics, and computer science, DeHeer says of the liberal arts college affiliated with the Christian Reformed Church. A new Integrated Science Research Institute will be both the home of and the catalyst for efforts to draw scientists from behind disciplinary walls and bring their special talents to bear on common projects. Students pursuing a new Integrative Science minor—along with those just wanting to join one of the institute's collaborative start-ups—can apply for research fellowships there. The institute will have a dedicated staff member (a faculty member serving on release time from teaching responsibilities), a lab with the latest visualization and computer modeling technologies, and workspace where the new collaborative teams can set up shop.

In addition, mathematical and computational spins will be added to nearly all life sciences courses, while computer science majors will study the biological dimensions of information theory. To enhance its classroom offerings, Calvin is looking for a new faculty member with training in biostatistics, bioinformatics, or genomics. To build its research base, Calvin will release a junior faculty member from some teaching responsibilities for two years in order to launch a new lab with a strong interdisciplinary bent.

The HHMI grant will also allow Calvin to nearly double the number of on-campus student researchers in its established summer research program from 64 to more than 100 undergrads with possibly another 30 placed in off-campus research settings. When choosing a research assignment, the new interdisciplinary research scholars will be urged to ignore traditional disciplinary boundaries. Their 15-month fellowships will bridge two fulltime research summers with parttime research during the intervening school year.

In addition, Calvin will put more resources into its ongoing science education outreach efforts in schools around Grand Rapids. The HHMI grant will pay 10 high school apprentices to work with undergraduate students in Calvin summer research labs and bring in 10 high school teachers each year to spend a week at Calvin's new interdisciplinary science institute. When this HHMI grant is over four years from now, integrated science teaching and research should be well-established and prospering at Calvin.

CARLETON COLLEGE

Undergrads Grappling with Biological Complexity

The intricate dance that coordinates an embryo's development into a functional organism relies on the precise interplay of many moving parts. Multiple genes must turn on and off in disparate cells at specific and varied time frames.

Although traditional research approaches can reduce complex biological processes like these to their smallest parts, they often fail to describe the elaborate interplay between those parts. Carleton College is using part of a new $1.5 million grant from HHMI to prepare its students to move beyond these traditional approaches to embrace and address real-world scientific complexity.

Previous HHMI grants to college have supported interdisciplinary and inquiry-based learning in undergraduate research and teaching. Carleton is using some of its new grant money from HHMI to develop programs that will prepare students to tackle scientific problems as teams, to analyze data with quantitative methods, and to communicate complex information effectively. The college will support its focus on complexity by strengthening faculty teaching and scientific skills and developing computer modeling collaborations between the science and the mathematics departments.

'The most important problems we face in science are problems of complexity,' says Fernán Jaramillo, associate professor of biology and HHMI program director at the Northfield, Minn., college. 'Think of the problems we are trying to solve in neuroscience, genomics and the environment. All of them require the input of many voices from many different fields. And computer modeling is essential for translating and coordinating these voices.'

In biology, Carleton aims to develop new computer modeling courses and exercises that are relevant to such varied areas as neuroscience and population dynamics. The physics and chemistry departments will develop enhanced computer models of both quantum and classical system dynamics at the atomic and molecular levels. And the environmental science faculty will revise its curriculum to use computer modeling techniques to help students analyze and better visualize the complex relationship between social and natural phenomena.

Faculty workshops focusing on complex systems will provide the opportunity for faculty to update, sustain, and develop their scientific and teaching skills as they relate to complex systems, interdisciplinary modeling, computation, visualization and team-based learning.

"We need to increase the competency of our faculty in terms of exploring complexity if we are going to prepare students to tackle our most important problems," Jaramillo says.

CUNY HUNTER COLLEGE

Minority Students Find Springboard to Science

Hunter College, part of the City University of New York, is used to working without a roadmap. Its science programs, for example, do not follow the traditional trails to success blazed by other schools because Hunter doesn't attract the traditional student. "Almost all of our students work and many can only attend school part-time," said Shirley Raps, chair of the biology department.

So Hunter decided to use part of its $1.4 million science education grant from HHMI to expand a program that pays students to go to school full time and work in a research lab. In addition, the students get career counseling and are mentored by faculty members. "They are essentially allowed to just do research and really see what it is all about," Raps said. "They really get turned on to it."

The current program, funded by the National Institutes of Health, is designed to encourage students from groups underrepresented in the sciences. The HHMI money will expand the same program to women and students from underprivileged backgrounds. Raps said the program has been very successful to this point—more than half of the 56 students have gone on to either a Ph.D. or an M.D. program—and they hope it will be even more successful with the HHMI money.

Hunter students will also have the chance to do research outside of the college, with a program at the Marine Biological Laboratory in Woods Hole, Mass. There, the students immerse themselves in a research environment: they work side-by-side with high-powered researchers and eat lunch with Nobel Prize winners. Four students will be matched with four scientists for the summer. In previous years, the program has resulted in students contributing to multiple publications and poster presentations at major national and international meetings.

"It just opens up their horizons, which is what we want to have happen," Raps said. "They will be very well known scientists as their careers progress. I'm convinced of that."

COLBY COLLEGE

Getting Through The Gateway Is Central To Colby Plan

For many freshmen, the "gateway" courses in biology, chemistry, and mathematics are killers—killers of interest and of potential careers in science. The gateway shock phenomenon is a particular problem for first-generation college students and those from minority groups who are already underrepresented in science. Getting them through the fundamentals and giving them a taste of doing their own research is one of the prime goals of Colby College's new program, part of a $1 million HHMI grant to improve undergraduate science education.

Losing students from traditionally underrepresented groups who come to Colby to major in science has been a growing source of dismay, says biologist Andrea R. Tilden, who will coordinate the new HHMI program to address the problem head-on. "This is something we've been working on for the past six or seven years," Tilden says. "We've come up with a variety of grassroots initiatives but this will allow us to pay a lot more attention."

The project, which aims to get and keep science majors, will begin with a six-week, summer program for students between high school and college, mixing an intense research experience, close faculty mentorship, and a review of basic math and chemistry skills. The students will continue to be mentored and serve as members of research labs through the regular school year, while their connection to others in the group will be strengthened during special workshops and social gatherings.

As part of the college's efforts to give students a taste of how science is done in the real world, all Colby science students will be hearing a lot about statistics and interdisciplinary perspectives. The HHMI grant will speed faculty retraining and a curriculum overhaul that will bring statistical concepts into virtually every biology class, from neuroscience to genetics. Outside the biology department, computer science majors will find themselves wrestling with problems drawn from molecular biology and genomics. In addition, Colby will broaden its faculty expertise by hiring two postdoctoral fellows with recent cross-disciplinary training in computer science and biology. Other HHMI-funded programs will hone the leadership skills of women science faculty and underwrite the mentoring of future science department chairs at Colby.

A small college of 1,800 in a small town of just 15,600, Colby has always had a close relationship with the local public schools. The HHMI grant will make that relationship even closer, supporting more "scientists in the classroom" units, loaning more lab equipment, giving more small grants directly to science teachers, and hiring more high school students as summer research assistants.

A special outreach target for Colby science students will be the 4th and 5th graders at Waterville's Hall School. Research by Colby education faculty has identified this age group as the time boys lose interest in school and girls lose interest in science, says Tilden, who confesses to a vested interest in the outcome. "I have a fifth grader of my own."

COLGATE UNIVERSITY

Students Learn by Taking a Systems Approach

Systems biology, a field that lies at the nexus of biology and mathematics, employs interdisciplinary approaches to address complex problems. Students at Colgate University will have a chance to study this nascent discipline in a new mathematical biology major, funded with part of a $1.2 million HHMI grant.

"We're approaching this field as the study of networks of molecular interactions, like gene expression patterns and protein interactions," says Kenneth D. Belanger, associate professor of biology and HHMI program director for the Hamilton, N.Y., university. "Students in mathematical biology will use computational techniques to solve biological problems."

Systems biology is a field that is so new that eminent scientists still argue about its definition. They agree, however, that systems biology seeks to integrate complex data about the interactions in biological systems from diverse experimental sources. Incorporating and analyzing such vast amounts of data requires that students not only understand biological science, but also have a firm grasp of computation and mathematics.

To build the mathematical biology major, Colgate will hire a tenure-track systems biologist to teach existing courses and develop new courses in both the biology and mathematics departments. The grant will also provide funding to link mathematics faculty with professors from other departments to develop lessons to teach mathematical applications. "Getting a systems biologist on faculty will allow us to link departments in the sciences at a time when we have opened an interdisciplinary science building," Belanger says. The newly opened Ho Science Center houses classrooms, research and teaching labs, and offices for five different science departments. By intermingling faculty from different departments, the facility promotes interactions between students and faculty from various disciplines.

As the university strengthens its connections between mathematics and biology, it will be better equipped to help students appreciate those connections — even in introductory courses. One strategy will bring students from two courses together to work on biological problems requiring mathematical analysis. Biology and statistics students might come together to identify genes that affect quantitative traits, for example, while math and geography students might tackle determining how fast a disease epidemic is likely to spread.

COLLEGE OF CHARLESTON

Learning Science—It Takes a Community

First-year students, especially people from underrepresented groups or the first in their family to attend college, often feel disconnected from the rest of the college community. The College of Charleston hopes to fix that by creating a community to support and encourage them.

The college, a first-time HHMI grant recipient, will use part of its $1.5 million award to create "learning communities" focused on three interdisciplinary areas: computational biology, chemical biology, and neuroscience. Students with similar interests will study, take classes, and live together in these learning communities during their first year in school.

"Without that kind of connection, many students feel very alone, and they leave," said Norine E. Noonan, dean of the School of Sciences and Mathematics and program director of the HHMI grant. "They might actually be doing well academically, but it's the culture and community and peers that keep them here. We also have a fair number of first-generation college students, and they have no framework or context for the college experience."

The students in these science learning communities will take the same courses and attend regular group sessions to review each week's work. Students who live on campus will be assigned the same residence hall. Each community will have 30 to 40 first-year students.

"We want to get students into their disciplines culturally, and we want them in an interdisciplinary science environment as soon as possible. We felt we were missing the boat by waiting until the second semester of sophomore year (to immerse them in that environment). HHMI offered us an opportunity to start at the freshman level," Noonan said.

In each learning community, a junior or senior who is doing research in a relevant area will serve as a peer facilitator. He or she will coordinate weekly discussion sessions. The peer facilitators will receive training from faculty and the college's First-Year Experience office. "These facilitators also will talk to students about the college experience, their research, careers in science and the health professions, and what it's like to be a science major," Noonan said.

The learning community concept has been used in other programs at the College of Charleston for two years. Noonan said the system has improved grades and increased the retention rate of students. The College is making a special effort to recruit African American students to join the science learning communities. African American students make up about 8% of the College's 10,000 undergraduates.

The College will also use the HHMI grant to fund 27 summer research fellowships, add two science faculty members, assist students and science teachers at a local high school that is predominantly African American, and expand the activities of the Lowcountry Hall of Science and Math, a resource center for middle- and high-school teachers in the Charleston area.

COLLEGE OF WOOSTER

Summer Program Key to Wooster's Success

Faculty at the College of Wooster don't want to just attract students to science—they want to keep them engaged in science throughout their college years and beyond. One trick to doing that, asserts biology professor Bill Morgan, is to draw students from groups underrepresented in the sciences into independent research from the moment they set foot on campus.

Every student who graduates from the College of Wooster conducts independent research. For most, this takes place during their senior year. Now, using part of a $1 million HHMI grant, Wooster is creating a summer program that will expose economically-disadvantaged students and those from underrepresented groups to the excitement of scientific discovery before they start their freshman year. The program will show these students that science is more than a classroom ordeal, says Morgan, the HHMI program director.

An initial group of 10 students will spend four weeks training in a science field of their choice, gaining experience in teamwork, data collection and lab skills with help from faculty and student mentors. "What we hope is that this initial exposure will make science more exciting and less abstract to these students," Morgan says. "And ideally they'll reflect on what they learn in the summer and how it relates to what they do in class during through the school year."

Through a new HHMI-funded research collaboration with the nearby Cleveland Clinic, these students will have preferential opportunities to pursue biomedical research in a clinical setting. The college is also offering a range of summer research opportunities in the life sciences through collaborations with the Ohio Agricultural Research and Development Center. "We need to increase minority representation in the sciences so that research draws from varied perspectives," Morgan says. "Furthermore, if there's a subset of the population that's excluded, then the research productivity of this country won't be as strong as it could be."

DAVIDSON COLLEGE

Mid-Course Correction Saves Diversity Program

Halfway through its last four-year HHMI grant, Davidson's original Strategies for Success in Science program to increase diversity in the sciences was anything but a success, according to Verna Miller Case, chair of the biology department and program director of the new HHMI grant.

Then the Davidson faculty coordinators went to an HHMI-sponsored Diversity in the Sciences symposium at Harvard University and came back with an action plan. For the next school year, they set higher standards and higher rewards for Strategies participants. They recruited three former program students to serve as mentors.

"That really turned it around," Case recalls. "Once the mentors took ownership, they started running the program." Participation and students' confidence in their ability to handle science courses shot up. So did their school performance. Matched to Davidson students from similar backgrounds, the program's participants had better grades in their gateway science courses. Gateway courses are introductory courses that provide a critical foundation for science majors. "We're pulling some of that success back into this grant," Case says of the new $1.5 million HHMI proposal.

The new grant will continue the Strategies program, creating a community of peers and mentors to carry students beyond the gateway year and keep them interested in science. But minority students are not the only ones who crash and burn in their introductory courses, so they will extend the ideas to more students. "There are too many students who say they've come to Davidson to become scientists or doctors but then in the first year, we lose them. They end up majoring in other fields," Case explains. "In today's world, we need to increase both the number and the diversity of students in the science pipeline." To help, Davidson will set up a new Mathematics and Science Center near the dorms where floundering students can come early and often for help. The Davidson, N.C., school will also do a national search for a gifted science educator to run the center and recruit a staff of paid peer tutors.

Once they are hooked on science, the HHMI grant will encourage more Davidson students to participate in the school's undergraduate research program by funding student-faculty research collaborations in the summer. Further, HHMI funds will promote student-faculty collaborations in the interdisciplinary fields of genomics and neuroscience..

Davidson will also continue its science outreach efforts by creating an outreach office to better coordinate its student and faculty-run school and public science programs. Davidson's "Herp Day," when the Herpetology Department throws snake and reptile demonstrations, is already famous throughout North Carolina's burgeoning Piedmont region.

DREW UNIVERSITY

Undergrads Take on Great Challenges

Several years ago, Drew University faced a dramatic decline in students majoring in science. The situation came as a shock, because as recently as 2001, the number of students majoring in the sciences at the university well exceeded the national average for highly selective, independent liberal arts institutions. Hoping to remedy the situation, the school sought the advice of an external review committee of distinguished scientists. Using their recommendations, Drew's faculty developed a new vision for the future of science at their university.

As a result, Drew students will benefit from a revitalized curriculum and student research projects are now focused on great challenges in science, such as Alzheimer's disease, global warming and cancer—all with the help of its first HHMI grant for $1.1 million.

"With this approach we are looking to generate excitement for the sciences by teaching an aspect of science related to the challenges facing scientists right now," says Roger Knowles, associate professor of biology and HHMI program director for the Madison, N.J. school.

The university will develop a multi-disciplinary general education course around each great challenges theme, incorporating case studies, epidemiologic analyses, current research, and the ethics of drug trials to give students their first taste of a great challenge topic.

"We are going to initially focus on Alzheimer's disease as a theme and use it as a frame work for lectures, labs and research." Knowles says. While Alzheimer's disease will be the school's first great challenge, they will tackle a new theme every two years.

The program will culminate in students' junior and senior years, with a year-long interdisciplinary research course focused on employing the knowledge, techniques, and technology from different scientific disciplines. The initial focus on Alzheimer's disease will draw on the expertise of Drew scientists working in the areas of cell and molecular neurobiology, systems neurobiology, biochemistry, bio-psychology, mathematics, and statistics.

FRANKLIN & MARSHALL COLLEGE

Collaboration with Local Clinic Makes Franklin's College Wise

Since 1787, when Benjamin Franklin put up 200 English pounds to help found a college, Lancaster County in southeast Pennsylvania has been home to what is now Franklin & Marshall College. In 1989, pediatrician D. Holmes Morton purchased an untillable field from an Amish farmer, and made Lancaster County home to Morton's Clinic for Special Children. A new $1.3 million HHMI grant will build on a collaboration between the college and the clinic, creating an exciting opportunity for undergraduate students to contribute to real-world genetic research at the clinic. Morton's clinic specializes in diagnosing and treating inherited metabolic disorders in children from Amish and Old Order Mennonite communities.

Faculty members at the college have been collaborating with Morton since 2006 when the MacArthur Foundation fellow first began teaching an undergraduate medical genetics course on campus. The new HHMI grant comes on the heels of an agreement last July linking genomic data from Morton's clinic to Franklin & Marshall's undergraduate interdisciplinary research program. Researchers at the clinic have gathered genetic data on more than 80 different metabolic disorders—including glutaric aciduria, maple syrup urine disease, Crigler-Najjar syndrome, and medium-chain acyl-CoA dehydrogenase deficiency—from families in the "Plain" communities of Lancaster County and from other children around the world. The college anticipates that the grant will support 32 students working at the clinic and on campus to mine and analyze this wealth of information to identify the distinctive patterns of mutation, deletion, or repetition that might underlie these rare metabolic disorders. The hope is the information will eventually improve diagnosis, identify new drug targets, or sharpen current therapies. The grant will support an additional 32 students who will work on other projects in the areas of bioinformatics and genomics.

The collaboration illustrates the changing scientific landscape where computer science, mathematical modeling, and genetics are rapidly converging. It also illustrates the need for colleges to prepare biology students for the interdisciplinary world of science, according to Richard Fluck, a Franklin & Marshall biology professor and associate dean who helped draft the HHMI proposal. The grant is the final element in what Fluck describes as "a perfect academic storm" at the college—a new $50 million science and philosophy building, a new commitment to bioinformatics throughout the science curriculum, and a new effort to raise science literacy, both on campus and off.

HHMI funding will allow Franklin & Marshall to create an interdisciplinary major in bioinformatics to support this research and retrain faculty to infuse current biology, chemistry, and computer science courses with new cross disciplinary perspectives. It will also enable the school to hire two new bioinformatics faculty, one in biology and one in computer science. Even non-scientists will get a taste of bioinformatics in new general education courses aimed at putting this scientific revolution in a broader intellectual context.

As Franklin & Marshall gains experts and expertise, it will also introduce bioinformatics to science teachers from Pennsylvania's educational special needs and enrichment district for Lancaster County. Workshops and on-campus lab experiences will prepare teachers to spread the message that today's sixth graders are tomorrow's interdisciplinary scientists.

FURMAN UNIVERSITY

Furman Creates a New World of Science for Students

This year is the "Year of Science" for Furman University, and the school has much to celebrate: it will open a new science center that brings together the physics, earth and environmental science, chemistry, and biology programs in a single building, creating links between the sciences more numerous and substantial than ever before. And its new $1.2 million HHMI grant will allow the school to develop new math and science courses and research experiences accessible to a broad range of high school and college students.

"This is our first HHMI grant, and it comes at an extremely pivotal time in our history," said chemistry professor John Wheeler, program director of Furman's HHMI award. "The grant will allow us to develop increased interdisciplinary programs through a host of new mechanisms and give us a new world to offer Furman students and the Greenville community. We are thrilled."

One new program for the Greenville, S.C., college is a partnership with the University of Florida. Furman will send up to four undergraduates each year to Florida and international sites in France and Argentina to engage in summer research in a setting not typically available at a liberal arts college. In addition, 20 Furman freshmen will participate in a weekly teleconference seminar with their peers at Florida during the academic year, which will include presentations from both Furman and Florida research scientists. Furman's twenty HHMI students each year will also work in research labs for 12-15 months as colleagues with Furman faculty.

A second program will connect unique courses in math, physics, genetics, and chemistry in a new interdisciplinary program for 20 sophomores. Advanced math and physics courses will be team-taught by professors of both subjects, as will genetics and bioorganic chemistry. Students who complete this program will be eligible to participate in Furman's new quantitative science curriculum.

"During the last 10 years there has been an explosion in the power and capacity of mathematics and computer science to solve biomedical problems," Wheeler said. "Comfort with computers and the fundamental tools of mathematics is essential to all students entering the life sciences." The quantitative science curriculum will help life science majors master these tools so they can investigate many different biological questions, ranging from the functions of specific genes and proteins inside a cell to classifying those animal, plant, and earth elements found inside an ecosystem to understanding new ways to medically image the body.

These exciting new developments will be celebrated in the coming year for all students on campus through a special "Celebrate Science" event. The school will suspend regular class meetings for this special occasion so that all Furman students, as well as local high-school students, can attend oral and poster presentations by their peers and other special events, including guest lectures by nationally-recognized speakers.

GEORGETOWN COLLEGE

Showing Students that Science Isn't Scary

Georgetown College faculty know that incoming freshmen are often deterred by fear from taking science courses, but with $1.3 million in new funding from HHMI, the college is designing new programs to bolster student confidence and excitement in science.

The college is located in Kentucky's Bluegrass region, where the Georgetown community convinced the Kentucky Baptist Education Society to establish a college in 1829. Today, the college draws students from throughout the country, with the majority coming from Kentucky and neighboring Appalachian regions. These students arrive at Georgetown from a variety of backgrounds. A high percentage come from very rural areas and many are the first from their families to pursue a college education.

The school wants to equip all of its students to appreciate science's impact on society and to prepare them to pursue scientific careers. "We want to show students their fears are unfounded," explains HHMI program director Mark Christensen, a biology professor at Georgetown. "A lot of students have great aptitude and potential in science that they're not even aware of." To do that, the college plans to help its students to discover the breadth and excitement of scientific discovery through a variety of interactions with working scientists.

A science careers seminar will introduce students to professional scientists from academia, industry, government, and non-profit organizations. The seminar will help create and foster mentoring relationships between freshmen and sophomores and scientists from Georgetown or other institutions, giving students an opportunity to become more comfortable with research and learn what skills they need to succeed in science, Christensen says.

To ensure that its students are ready to confront the kind of science researchers are doing today, Georgetown is also revising its curriculum, designing new courses that emphasize computation and bioinformatics. "Our idea is to link lab work with bioinformatic methods," Christensen explains. "We want our students to learn how to search genomic and proteomic databases and use the output to design and interpret their own experiments."

As they move toward graduation, students will have access to a new, HHMI-funded summer research program. Students can choose to do research with a Georgetown faculty member or a scientist at another institution. Alternatively, students can work with a faculty mentor to design and test a short-term research project that can be incorporated into one of the college's introductory science courses.

GONZAGA UNIVERSITY

Learning from Native Tribes Leads to Better Education for Everyone

When Brook Swanson and his colleagues first met with the Spokane Tribe elders, they brought an agenda.

But the Gonzaga University biology professor quickly learned that relationships, not lists, are the best way to start improving science education at the tribe's K-12 school in Wellpinit, Wash. With part of the college's first HHMI grant for $1.2 million, the biology department is expanding its relationship with the tribe to help bring science teaching across the cultural divide.

Before that first meeting, the faculty at the university in Spokane, Wash., knew they needed to learn from the tribal elders, mostly older women, and Native teachers. Previous programs, both at Gonzaga and across the country, have not been particularly successful attracting Native Americans into science careers.

In the year since, Swanson has had his first lesson: Native Americans think about science differently. "They don't treat things like science as a separate discipline, but rather as one of many interconnected things that dictates our view of the world," he said. "How you interact with your environment is an integral part of your community and your spirituality."

That means Native Americans often talk about science through stories, filled with context and subtext and nuance—something modern science teaching often lacks. The new curriculum Gonzaga faculty and students are developing for the school will include lots of stories, through case studies or the history of science. This process of evaluating cultural differences will be just as valuable in teaching other students, who benefit from learning science in context, Swanson said.

The university has a long history of working with local tribes, and its biology department is renewing its commitment to outreach. Working with a public school—the Spokane Tribe's school, another Native American K-8 school on the Colville Reservation, or a local public school—will be mandatory for students following the school's research track, which will be expanded with the HHMI grant. "By having to do outreach, students get interested in teaching," said biology professor Nancy Lynn Staub, Gonzaga's HHMI program director. "We're hoping to attract some of our bright science and math students into teaching science."

In addition to its K-12 outreach, Gonzaga faculty hope to begin teaching joint classes with a tribal college and to start trying out some of their ideas for how to teach with more cultural sensitivity. Eventually, the university hopes to publish its findings in a science education journal.

The faculty are excited about the program, and Swanson says the tribe's members are equally enthusiastic. They understand the problem with the dearth of Native Americans in science each time they have to hire a fish and wildlife biologist or doctor from outside their community. "They recognize this as a major issue, but they also have no desire for us to come in and tell them how to teach their students," Swanson said. "And we don't want that either."

GRINNELL COLLEGE

Dissolving the Divisions at Grinnell

At first glance, the titles might seem out of place on the roster of science courses: Food: To Cook, To Taste, To Appreciate. PhysicoBiology: Quantum Uncertainty and Uncertainty about Consciousness.

In fact, the titles are cleverly conceived to pique the curiosity of undergraduate students. But beyond the clever titles is a new way to approach science through interdisciplinary classes taught by two members from distinct disciplines. The Food course, for instance, will examine food science from the perspectives of chemistry, biology, and psychology and be taught by a chemist and a psychologist. The PhysicoBiology course will explore the interface of biology and physics using examples like the link between human consciousness and quantum physics and be taught by a biologist and physicist.

These are just a few of new the interdisciplinary courses that Grinnell College is creating with part of its $1.2 million HHMI grant. By 2012, the college hopes to add as many as 16 interdisciplinary classes, which will span math, psychology and the biological and physical sciences.

The idea for these new courses comes from Grinnell's experience over the past four years, when a previous HHMI grant created new opportunities for science professors to attend one another's courses. A chemistry professor might sit in on a physics course, for example, or a physics professor might take a biology course. The idea was to allow faculty members to observe how students learn another discipline so they could improve their own curricula and teaching methods and be able to better work with a colleague from another discipline, especially across the biological/physical sciences divide.

"By being students ourselves in these courses, we can see how they are taught," said Mark E. Levandoski, associate professor of chemistry and program director for the grant. "We've found that students tend to compartmentalize—you show them an equation in chemistry and they think it's different from the same equation they see in physics."

Not only did professors find the experience invaluable, they decided to take it a step further. Grinnell faculty members now are creating a team-teaching approach to the integrative science curriculum, like bioinformatics or the classes mentioned above.

GUSTAVUS ADOLPHUS COLLEGE

Imaging Key to Joining Chemistry and Biology

Introductory chemistry and biology classes are typically taught in isolation. But the subjects are inextricably linked, and faculty at Gustavus Adolphus College plan to use modern imaging technology to allow students to see that interdependence for themselves.

A new visualization and imaging center, paid for with part of a $1 million HHMI grant, will allow students to see the relationship between chemical and biological processes. "Advanced visualization tools aren't typically available to undergraduate students," explains Jonathan M. Smith, an associate professor of chemistry at the college in St. Peter, Minn., a first time HHMI grantee. "With this new laboratory, our students will be able to see why chemistry is important to biology and vice versa using some of the same imaging instruments used in professional research laboratories."

The college is still deciding which imaging tools will best help chemistry and biology students appreciate the relevance of both disciplines. But they have already chosen a variety of key scientific concepts that will provide excellent opportunities for students to learn science by seeing it in action. For example, using an instrument that measures the amount of fluorescence in a leaf, chemistry students can view how light is absorbed and released by chlorophyll molecules. That demonstration will bring oxidation-reduction reactions—the chemical processes that drive photosynthesis—to life in a visually compelling way, Smith says. The same images will help biology students understand the great amount of chemistry that goes into photosynthesis.

Introductory biology and chemistry will still be taught separately. Smith says faculty will coordinate the coursework in the two classes, with assignments in each tailored to progress in the other.

Students and, with HHMI's grant, local high school teachers will have an opportunity to put their newfound appreciation of biology and chemistry to use when they attend the college's annual Nobel Conference. The Nobel Conferences focus on scientific issues of theoretical importance and social significance. Over the years, the conferences have brought to campus some of the world's foremost academic leaders and research scientists—including more than 60 Nobel Prize winners. The two-day event typically attracts about 5,000-6,000 people, including approximately 2,500 college and 1,700 high school students and their teachers. Through pre-conference meetings and a follow-up program with Gustavus Adolphus faculty, high school teachers will be able to integrate the conference topic into their curriculum during the upcoming academic year. "It's really a transformative educational opportunity for the community," says Mary E. Morton, the HHMI program director and Gustavus Adolphus' provost and vice president for academic affairs.

HAMPTON UNIVERSITY

Ph.D. Prep Program Aims High

Edison Fowlks would like to recruit future Ph.D. students to Hampton University the same way basketball coaches recruit future NBA players. He dreams of going into urban high schools looking for academic talent, then convincing students and families that biomedical research can be as exciting as and provide more security than professional sports. Fowlks doesn't have a highlight reel showcasing his recruits yet, but thanks to a new $1.2 million HHMI grant, he does have the go-ahead to start interviewing rising sophomores at Hampton for the first of 10 Pre-Ph.D. Scholar positions.

Hampton, a historically black university in Virginia that traces its roots to the Civil War, will use its HHMI grant to transform science education at the school. The Pre-Ph.D. Scholars that Fowlks recruits will benefit not only from intensive preparation for college life while they are still in high school, but also from a revamped science curriculum at the university. Fowlks, a biology professor and HHMI program director, used the recommendations of the National Research Council's "Bio 2010" report as a blueprint for overhauling the Hampton program to make it highly interdisciplinary, inquiry-based, and grounded in the research lab experience.

A first step will be the complete renovation of an existing lab into a modern molecular biology facility where students, guided by faculty mentors and a dedicated technician, can gain firsthand research experience. Fowlks hopes this will help them qualify for summer internships with government and institutional research facilities. Next will be a series of workshops led by outside experts that will help Hampton faculty create new classes in the cross disciplines of genomics, systems biology, and computational biology. This will also help faculty bring new interdisciplinary dimensions to current courses in genetics and embryology.

To pull more qualified students into the bioscience pipeline, Hampton will offer a summer program for entering freshmen that will look at DNA as an information science problem. The classroom portion will be taught by a faculty triumvirate—a molecular biologist, a computer scientist, and a mathematician. The lab segment gives students experience doing gene expression experiments in yeast before analyzing their results in a bioinformatics lab. Fowlks says the summer program will pull together all three strands of the new curriculum, providing incoming students with an interdisciplinary, inquiry-based, research experience.

The best students from the entry-level program will become Pre-Ph.D. Scholars, Fowlks says. Every two years, a new cohort of 10 will be chosen. The scholars will be given mentors, stipends, and summer research placements. They will prepare for the GREs, learn presentation skills, and attend scientific meetings. Most importantly, the scholars will be exposed to the research science life. "We want to have successes," Fowlks says. "The students who go through this program will go onto graduate programs at Harvard, MIT, or Berkeley."

HARVEY MUDD COLLEGE

Freshmen Tackle Biology and Computer Science at Once

At Harvey Mudd College the unicycle is a favorite form of transportation. So it is safe to say students at the college are comfortable taking unique and innovative paths.

That"s why the school is confident that incoming freshmen are up to the challenge of tackling introductory biology and computer science as a single course. The biology and computer science departments will merge their first year core classes into one full-year computational biology course, with the help of a $1.5 million HHMI grant.

"Because the college caters to students who are interested in the physical sciences and engineering, many of those students don"t really appreciate what modern biology is all about," says Catherine S. McFadden, professor of biology and HHMI program director for the Claremont, Calif., college. "One of the things we are hoping students take away from this experience is that the problems of biology can serve as the motivating interest for computational problems."

Harvey Mudd is a liberal arts college that trains primarily scientists, engineers, and mathematicians. Before these students settle into their major, however, they must tackle a core curriculum that includes a healthy dose of mathematics, science, and engineering, along with humanities and social sciences—or "HumSocs." At such a science-intensive school, some students refer to biology as a "HumSoc," McFadden says. "Many of our students see biology as one of their freshman courses that they must grit their teeth and endure."

By merging biology and computer science into one course spanning two semesters, Harvey Mudd"s faculty hope to draw on the similarities between the two disciplines so that students will begin to see how the explosion of genomic and molecular information and the complexity of the brain serve as biological as well as computational challenges.

"Students will be learning to write basic computer code at the same time that they will be learning about biological coding [in DNA]," McFadden says. "They will see the conceptual and theoretical link between computer science and biology."

Faculty and students from the two departments will develop the course over the next year. Starting in the fall of 2009, 36 students will participate in the team taught pilot course. After two years, the school plans to expand the course to its entire freshman class.

HAVERFORD COLLEGE

Computing Emphasis New to Haverford Classes

The Haverford College faculty have always prided themselves on their commitment to multidisciplinary education. Now, with a $1.4 million HHMI grant, they're aiming to strengthen that commitment by infusing a dose of computational science into the biology and chemistry curriculum.

"Computational sciences typically haven't been taught to undergraduate biology and chemistry majors," explains Robert Fairman, the school's HHMI program director. "We want to bring them into undergraduate science education the same way they're being taught in graduate schools now."

The college in Haverford, Penn., plans to meet that goal in a number of ways. Students will be able to pursue a new concentration in scientific computing with access to courses ranging from computer science to bioinformatics to systems biology. And the college will hire a visiting scholar with a Ph.D. in computer science, who will be responsible for developing new ways to incorporate quantitative elements into undergraduate science courses.

Bioinformatics—a field that looks for biological clues in digitized data—connects computer science and biology in obvious ways, Fairman says. The task now is to find additional opportunities to infuse mathematics, statistics, and other related disciplines into coursework in biology and chemistry. "The post-doc's role will be to work with us in these areas," Fairman says. "We're going to be running faculty development workshops on how to modify our courses to include more computational components."

HHMI funding is also being used to expand Haverford's community outreach programs, including a summer science program that offers students from under-represented groups—or from families with little or no college experience—an introduction to college-level coursework. First launched as a pilot program in 2006, the program gives students room, board, a stipend, and five-weeks of personalized teaching in a small-classroom setting. "They learn chemistry, math, and writing, and we find that when they matriculate in the fall they do much better in school," Fairman says.

HOPE COLLEGE

Science Teacher Training At Core of Hope Program

Many successful researchers say that one good teacher changed their lives. Using part of its $1.4 million grant from HHMI, Hope College is expanding a program aimed at educating teachers who will inspire future generations of scientists.

Each year, six students interested in teaching K-12 science will be eligible for a fellowship that includes a $4,000 stipend, supplies, and travel funds to attend a scientific meeting. In the summer, the students at the Holland, Mich., college will conduct research with one or more faculty members, either laboratory research or work focused on science education. They will also develop educational activities for classes, which will then be tested in the precollege classroom.

Past participants in the program have studied the toxicity of copper-containing pond sediment on invertebrates and developed related hands-on activities for children, created interdisciplinary case studies on the global carbon cycle that ask students to integrate knowledge from chemistry and biology, and found that 3rd through 9th graders at Hope's summer science camps are primarily visual and kinesthetic learners. Each spring, the students share their ideas for how to teach science at a statewide science teachers' meeting.

Some of the students will test out their ideas at Hope's summer science camps, which bring preschoolers through ninth-graders to campus to learn about science. "We've always asked whether the pre-college students like the camps, but not what works and what doesn't in terms of learning," explained Joanne Stewart, professor of chemistry and director of the HHMI grant. "The education students have done some great studies in collaboration with education faculty."

Hope will use part of its HHMI funds to hire a new faculty member who can help students learn how to teach science. "We don't have a science education faculty member on staff, but for a small college, we have a large science program and a large education program," Stewart said. The students will also attend lectures given by local science teachers about different ways of teaching, different learning styles, and how to find a job.

In addition, high school teachers and their students will have their own chance to do research at Hope, with funds from the HHMI grant. A five-week program will bring 12 students and two teachers to campus to engage in research; the students also will attend career workshops, field trips, and sessions on applying to college. The program focuses on Hispanic, African American, and Southeast Asian students, as well as other groups underrepresented in the sciences.

KALAMAZOO COLLEGE

Kalamazoo Sends Students Away for Research

Most colleges want to keep their high-performing science students on campus under their faculty's supportive wing. Kalamazoo College has a different plan.

"Our HHMI funds allow us to do something other universities think is a little bit nuts," says Jeffrey Bartz, chemistry professor and program director of the college's $1 million HHMI grant. "Instead of keeping the money at home, we allow our undergraduates to pick their own summer lab experiences anywhere in the world and use our grant money to support them."

This is a smart bet for a school with only 1,300 students and finite research opportunities on campus. "We get to sponsor many more students than we would if we tried to keep our undergraduate researchers in house," Bartz said. "And they get to study what interests them instead of working where the money is."

The program also fits well into the school overall. Eighty percent of Kalamazoo's students spend six months studying abroad. To keep science majors immersed in research during that time, the college encourages them to find an HHMI international research scholar nearby to work with. If the scholar agrees, the college funds the collaboration. HHMI's international research scholars are promising scientists from outside the United States who are making significant contributions to understanding basic biological processes or disease mechanisms.

During the summer, only around a quarter of Kalamazoo's undergraduate researchers stay on campus. The others are as far away as Berkeley, Calif., Rome, and Copenhagen, Denmark. The new grant will allow Kalamazoo to continue to send 15 research students per year to other locations. "Working at a small school is tremendously rewarding. Our student-teacher ratio is 12:1, and we are able to mentor very closely," Bartz said. "We don't want to get larger, but we don't want to shortchange our students, either. The HHMI grant and the off-campus research program it sponsors will allow the science department to offer undergraduates everything they need for the future."

The grant will also support a program to bring outstanding researchers to the Kalamazoo campus for a lecture and class visits. Its outreach programs will include math tutoring for fourth and fifth graders, an algebra camp for middle school students who didn't pass a state test, and a week-long summer camp where high school students from across the country explore biomedical careers.

LEWIS & CLARK COLLEGE

Three on a Side: A New Type of Research Collaborative

To build a passion for a life in science, some colleges run summer programs during which undergraduates work on their own research projects. Some promote mentor pairings between science faculty and would-be science students. Others have outreach programs to pull in bright kids from groups underrepresented in science. Lewis & Clark College will combine all three ideas, thanks to its first $1.5 million HHMI grant.

The college will create 10 research teams each summer consisting of a faculty mentor, a Lewis & Clark undergraduate, and a high school or community college student from the Portland, Ore., area. The teams will work in labs at Lewis & Clark and the nearby Oregon Health & Science University. In recruiting students to participate, the college will focus on identifying potential future scientists, engineers, and mathematicians who might not thrive in a research environment without additional support. "They will be students who perhaps wouldn't otherwise be thinking of research as a career," says the college's Dean, Julio de Paula.

The collaborative teams will be part of a broader HHMI-funded move toward more interdisciplinary and research-based science at Lewis & Clark. Neuroscience and bioinformatics are particular areas where the college hopes to build interdisciplinary muscle. To prepare the current faculty, the HHMI grant will fund a series of yearlong workshops to bring them up to speed on the latest in neuroscience, bioinformatics, and biophysics. The training will focus on new computational and modeling techniques. The college will also add faculty with strong research backgrounds in these areas who are interested in undergraduate teaching. To nurture future candidates, Lewis & Clark will establish postdoctoral teaching fellowships for early career interdisciplinary scientists.

Perhaps the most intriguing combination of outreach, interdisciplinary science, and non-traditional partnerships will come about in a proposed computational biology course to be taught simultaneously at Lewis & Clark and over the Internet at universities in Kenya and Tanzania. Cell biologist and HHMI program director Deborah Lycan hopes to draw on professional contacts she made in East Africa while leading a Lewis & Clark semester abroad course. The course will take a year or more to plan, but Lycan believes that the technology of computational biology makes real time Internet collaboration possible. "These would be powerful tools for African scientists working on projects like sleeping sickness or Leishmaniasis (a disease caused by parasites) that are not funded at levels commensurate with their impact in these countries," Lycan says, painting a picture of undergraduate "lab partners" working on the same data, half a world apart.

MOREHOUSE COLLEGE

Instrumentation "Think Tank" Incubates Collaborative Spirit at Morehouse

Great ideas and interesting collaborations need a place to be born. At Morehouse College, a state-of-the-art instrumentation facility will serve as the incubator for both collaborative research and curriculum overhaul.

"Most of the students who come to the Morehouse biology department intend to go to medical school. The more we can successfully expose students to real-world research, the more likely they are to consider a career in research," says David Bennett Cooke, III, chair of the biology department and HHMI program director at the Atlanta-based school. Cooke points out that interdisciplinary collaborations drive some of the best research being done today, and the college wants to ensure students and faculty have the opportunity to engage in those types of studies right on campus.

Morehouse, a historically black, liberal arts college for men, will use part of its $1.4 million grant from HHMI to support the instrumentation facility that they hope will spark the kind of interactions that result in interdisciplinary collaborations.

"This instrumentation facility is a means to an end," says Cooke. "I like to call it a think tank for science where individual researchers will bring their technical capacity to this space and develop new areas of inquiry."

Initially, 10 researchers from the biology, psychology, chemistry, mathematics, and physics departments will have open access to the facility, which will house equipment like a fluorescent microscope, immunohistochemistry equipment, and microarray readers. Each of the researchers has committed to working there to develop interdisciplinary collaborations, even though they maintain their own labs.

"We see this as an opportunity for these researchers to create the relationships that will help to develop collaborations," Cooke says, noting that Morehouse faculty members have had many opportunities to engage in collaborations outside the college but few have had the chance to explore collaborative work at Morehouse. The instrumentation facility provides a space for researchers to collaborate with other researchers in their own backyard. "For example, a researcher may see a technique being used with plants and realize it can also be applied to other disciplines."

At the same time, the facility will provide the resources needed for teaching and student research in interdisciplinary sciences such as bioinformatics and neuroscience.

The 10 faculty members who will serve as the core researchers at the instrumentation facility will also work together to restructure the biology curriculum into an interdisciplinary research program. The program will begin with a course that introduces students to interdisciplinary research, and continue with a three-semester collaborative research experience that will serve as the basis of an honors thesis.

MOUNT HOLYOKE COLLEGE

Classes Make Physics Fun for Science Students

Physics tends to get a bad rap among college undergrads. Even though it covers spellbinding phenomena, like the birth of the universe and the inner worlds of atoms, too many students see physics as a painful ordeal endured on the way to earning a bachelor's degree, says Craig T. Woodard, a biology professor at Mount Holyoke College. "Many of our students prefer biology and take physics only because it's a pre-med requirement," he says.

But physics is integral to understanding biological processes both large and small, Woodard says. For instance, physical forces not only dictate how proteins fold into their characteristic shapes, but they are also critical in understanding human locomotion.

Now, using part of a $1.5 million HHMI grant, faculty at the college in South Hadley, Mass., are revising the introductory physics course to better meet the needs of life science students. The school is also building a new laboratory designed to build stronger research and curricular links between physics and biology. Dubbed the "gait analysis" laboratory, it will deploy high-speed digital video cameras, a force platform and a series of computers that will help students visualize and analyze motions and forces in the context of human motion. Many of the fears and misconceptions students have about learning physics are best challenged and debunked using examples drawn from everyday experience, Woodard says. College students are drawn toward understanding their own bodies and how they work so the physical nature of human locomotion is well suited for illustrating physical principles in a way that students can readily grasp.

"The idea is to make physics come alive," Woodard explains. The students wear a series of small reflectors outlining defined positions on their limbs (i.e. the hip, knee, and ankle joints) and move across a plate that is essentially a fancy three-dimensional scale. A computer helps quantify the nature of the students' movements through the forces they exert against the ground—and the ground exerts back up. This allows the students to compare the dynamics of walking, running, and jumping, or design experiments to test the effects of wearing high heels or loaded backpacks on the stresses acting on their limb joints.

Education in physics, as well as other science disciplines, is also being enhanced by an HHMI-funded program that unites faculty, college seniors and sophomores for summer research. Faculty call this the "cascade mentoring program" because it fosters a flow of knowledge from the faculty to students. Woodard says sophomores who participate in the program tend to be happier and more engaged in science education down the line. "We've always had more applicants than we could support, so we're pleased to be able to add to those numbers," he says.

Students from groups underrepresented in science also benefit from summer studies at Mount Holyoke. During the summer before they start their freshman year, highly-promising minority and economically-disadvantaged students come to the college for a month to work directly with Mount Holyoke faculty and students on research projects.

NORTH CAROLINA CENTRAL UNIVERSITY

Science Student Recruiting Starts in Middle School

Although North Carolina Central University is located within the state's Research Triangle region — a prominent high-tech hub—fewer than five percent of its students currently major in science. That's a troubling statistic for the school's science faculty. The university hopes to change that by recruiting promising students as early as middle school and engaging them in research through their undergraduate years, using a $900,000 grant from HHMI.

The program "will give continuity, which we think assures greater success," said Sandra White, director of the university's Center for Science, Math and Technology Education and co-director of the HHMI grant.

The historically black college in Durham, N.C.—the first state-supported liberal arts college for African Americans in the country—will bring in 36 promising 11th-grade students from science enrichment programs the university already has in place at local middle and high schools. The students will attend a summer program for two years, doing lab research with the school's faculty members while also attending SAT-prep workshops and sessions on career possibilities in the sciences. During the school year, the students will continue their research and attend Saturday academies, which will include both new research experiences and tutoring opportunities.

Twenty four of those who participated in high schools will be asked to continue into the undergraduate years at North Carolina Central. During the academic year, these first- and second-year students will receive mentoring and career support, participate in tutoring sessions, and attend scientific conferences. The students will participate in six-week summer research internships, either with the university's own faculty members or those from Duke University, the University of North Carolina-Chapel Hill, and the companies and federal labs in Research Triangle Park. They will be paid a year-round stipend and given a laptop to encourage them to focus on school full time.

After two years in this tightly knit program, students will be able to join one of the college's already established research programs for upper-level undergraduates.

White is excited to see whether this long-term support makes a difference. "We now will be able to track students and see what the impact is when science enhancement is provided from middle school through college."

OAKWOOD UNIVERSITY

Convincing Students that Science is More Exciting than Med School

Science majors at Oakwood University used to think of their undergraduate education as a path to medical or dental school. But with a new 1.2 million HHMI grant, the historically-black, Seventh-day Adventist university is pushing more students toward a career in research. "There's a lack of black scientists and professors in this country," says Anthony Donald Paul, chair of Oakwood's biology department. "We want to do what we can to elevate their numbers."

The Huntsville, Ala., school has designed a staged approach to meet that goal. "The idea is to empower our students," Paul says. "We want to show them they can make a contribution to science and research if they so desire."

First, sophomores and juniors will take an elective course at the college that trains them in laboratory instruments and methods, such as electron microscopy, gel electrophoresis, chromatography, etc. That course prepares students for summer research opportunities at high-level institutions. Paul concedes Oakwood's facilities don't compare to those at major research institutions, but by training its students to use specific research equipment, instruments, and scientific procedures, the college prepares them to perform at a high level. "They don't get equipment shock," he explains.

After the class, Oakwood sends students off to do research at institutions that include Johns Hopkins, Duke, Harvard, Yale, the University of Michigan, and the Mayo Clinic. The school hopes to increase the number of students who participate in off-campus summer research from a current level of six or seven to 20 or more each year. "Our kids get really inspired by these summer opportunities," Paul says. "A lot of them have gone on for post-graduate education at these schools."

Oakwood wants to prepare more students for science careers from the beginning of their college education, with a newly-expanded initiative for early undergraduates. The program offers after-school tutoring and mentoring in the so-called gatekeeper courses, such as introductory biology, chemistry, math, and physics, which often serve as a barrier for first-generation college students or those from groups underrepresented in the sciences. The program gives students an opportunity to discuss concepts learned in class and to go over subjects they may not understand.

OCCIDENTAL COLLEGE

Science "Residency" Program Depends on Collaborations

Science education at Occidental College isn't just about sitting in a classroom.. "We want our students to learn science by getting their feet wet doing it," says HHMI-program director Christopher Craney, a professor of biochemistry. "It's the way future doctors learn medicine—through collaborations in professional settings."

Occidental faculty call their approach a "mentor-protégé collaboration" where students and senior experts work together on independent research projects. Funded in part by its $1.4 million HHMI grant, Occidental will make it possible for students to pursue these relationships off-campus, via new partnerships with Cedars Sinai Medical Center, Beckman Research Institute at City of Hope, and the University of Chicago Medical Center, among other institutions. A 10-week summer program will give students the opportunity to team up with professional scientists to investigate clinically relevant questions, such as potential applications of gene therapy in the treatment of pain and the mechanism of neuroendrocrine abnormalities in schizophrenia. Students will become part of research communities working to improve human health, attending conferences and professional meetings and generating publishable data, Craney says.

Occidental is also boosting hands-on research opportunities for future environmental scientists. Leveraging its location near the mountains, the desert, and the ocean, Occidental is offering a new, year-long course called "On the Edge: Life, Earth, and the Future." The focus is wholly interdisciplinary, Craney says. Coursework will draw from biology, geology, and environmental science for a comprehensive view of how ecosystems behave. Classroom lectures will be just part of the learning experience; students will also team up with senior experts for field research and gain exposure to practical tools such as geographic information systems.

The crucial link between research and education is teaching, so Occidental is using HHMI funds to train post-doctoral candidates who are interested in seeking faculty appointments at liberal arts colleges. "We want to involve our post-docs in research, but also in introductory and general education classes," Craney says. "The idea is to make our post-docs highly competitive for jobs at places like Occidental."

SAINT JOSEPH'S UNIVERSITY

Students Serving Science and the Common Good

Each week, several undergraduate and graduate students from Saint Joseph's University step away from the rarified air of academia and return to elementary school. Rather than seeking solace in a simpler time, they are actively developing and teaching science courses at four elementary schools in Philadelphia that serve low-income students.

Serving as teaching fellows, the college students help create and deliver hands on, project-based science lessons for elementary students, spending up to 15 hours a week in the classroom. The lessons are organized into semester-long units, generally with environmental science themes. Saint Joseph's will use part of a $1 million HHMI grant to support this program, which has had a positive impact on achievement.

"Saint Joseph's is an educational institution that is also committed to social justice and the common good," says Christina King-Smith, biology professor and HHMI program director at the Philadelphia school. "We're really excited about the GeoKids LINKS program that provides science enrichment activities in elementary schools."

GeoKids LINKS is a partnership with The Wagner Free Institute of Science, a Philadelphia museum founded in 1855 by merchant and hobby scientist William Wagner who believed science education should be available to all men, women, and children. Saint Joseph joined GeoKids in 2002 and since then students and faculty, local elementary school teachers, and educational specialists from the museum have worked together to align the curriculum with state standards and share information about best teaching practices for elementary students.

"Perhaps the most exciting thing about this program is that the children who participate in GeoKids LINKS improve more than children who don't get the program, as measured by test scores," King-Smith says. The improvements are seen in reading and writing, as well as in science. Elementary school teachers, too, say that participating in the program has made them more comfortable teaching science themselves.

The Saint Joseph's students serve as teachers and as role models for the elementary school children. And for the college students, the experience they get making science meaningful for children makes them better communicators and helps them stay in touch with the excitement of science discovery.

SAN JOSE STATE UNIVERSITY

Creating a New Tradition at a Non-Traditional School

Silicon Valley surrounds the campus, but for students at San Jose State University, the educational road to a high-tech career can be full of detours and dead ends. A new initiative to improve undergraduate biomedical education with the college's first HHMI grant is aimed at making that journey a little more direct.

"Our student population is non-traditional," says Julio G. Soto, an associate professor of biology and science education who will oversee the $1.3 million HHMI grant. "We have older people going back to school or starting a second career. We have students working fulltime and going to school almost fulltime. We have a lot of immigrants or students who are the first in their families to go to college." San Jose State's 23,000 undergraduates—41 percent of whom are over age 29—represent every stripe of California's diversity rainbow.

The school has about 1,000 undergraduate biology students, including those who hope to work not only in the traditional health and research sciences but also in forensic labs, biotechnology companies, regulatory agencies, and science classrooms. The challenges for these students are formidable. Beyond language, time, and cost issues, many struggle to survive San Jose's large introductory survey courses. Lab time is so limited that students often come up short on the bench experience needed to pursue internships—or the connections needed to find them. Soto says almost all of the students need more time doing real research to understand how modern scientific inquiry works.

As a start, the San Jose State biology curriculum will be overhauled to make all classes more inquiry-based, more hands-on, and more multidisciplinary. Freshmen will get more research-directed labs, transfer students will take a summer course focused on local ecological problems, and biology majors will enroll in a yearlong, team-taught eukaryotic cell and molecular biology course tied to cancer biology. To fill current gaps in faculty expertise and expand opportunities for students, a bioinformatics specialist will be hired.

The grant will also fund 12 HHMI undergraduate research fellowships. The students will essentially live the research life for two years, joining a faculty mentor's lab to learn how to design, analyze, and write up experiments before traveling to scientific meetings to present results. Soto says the students could find themselves working on projects with real life applications such as signaling pathways in cancer cells, insect biodiversity, the evolution of snake toxin genes, or Y chromosome analysis in DNA forensics.

To make better use of opportunities off campus, the HHMI grant will be used to set up a clearinghouse to match students with internships at government agencies, like the California Department of Fish and Game or local biotech companies. Twenty students will be picked for professional development coaching—how to polish a résumé, write an application, or ace an internship interview.

Soto is most excited about the on-campus research fellowships. The previous undergraduate research program was much too small, he explains. "We'd always get these great applicants. The hardest part for us was to decide who was going to participate. I always hated doing that part."

SMITH COLLEGE

What Comes Next in Science Education

During the past two decades, Smith College has been transforming it curriculum and facilities to move science education from "cook book" instruction to experiential, problem-based learning. HHMI grants over the last 20 years have been critical in helping Smith create a science education philosophy that actively engages students in the excitement of scientific inquiry, says Tom Litwin, director of Smith's Clark Science Center and program director for its HHMI grant.

But just as important, the HHMI grants have provided inspiration for the faculty to evaluate their own teaching and research, "The grants have created an environment where the faculty no longer separate their teaching and research activities," Litwin says. With the award of its fifth HHMI grant, this time for $1.3 million, Smith will build on the foundations that their partnership with HHMI has enabled them to create. Litwin says this continuity is at the core of Smith's success in developing new models for undergraduate science education.

One such model is the creation of resource centers at Smith for student-faculty research built around research questions, rather than traditional departmental structures. "Scientific inquiry has, by necessity, become increasingly interdisciplinary and our teaching environment needs to reflect this," Litwin says. A previous HHMI grant created a center for molecular biology and another for microscopy and imaging. Each was equipped with state-of-the-art instruments and a fulltime technical instructor. Experience has shown that undergraduates working with faculty mentors can explore some of the most interesting research questions of the day—if they have the necessary tools and encouragement. These centers, along with a proteomics center paid for by the National Science Foundation, are constantly in use by more than 40 faculty members, representing 6 departments and over 200 undergraduates. The new HHMI grant will upgrade the existing centers and add two more. One will focus on molecular structural analysis, with equipment for nuclear magnetic resonance spectroscopy.

The school will take a different approach with its other new center, which will be devoted to science outreach. An on-site K-12 science teaching specialist will provide the latest educational and technical support for students involved in Smith's science education efforts. For example, students already run a program on teen health issues with the Northampton city schools. The new science outreach center will also take a leading role in Smith's on-campus summer programs for science teachers.

From previous experience, Smith has also learned that a diverse student body doesn't come easily. Students in Smith's new diversity program will now start the summer before college with a science-focused orientation. "We found we needed to start talking with, and supporting students earlier in the college entry process," Litwin says of earlier programs targeting women from groups underrepresented in the sciences or families where neither parent has a bachelor's degree. Besides a summer's head start, the HHMI grant will give the students a ready-made social network of faculty and student mentors, continuing academic support, and an early push toward the research lab. An assessment initiative working in parallel with the program will help the faculty understand what is working, and how best to implement improvements.

SPELMAN COLLEGE

Spelman Raises Mentoring Female Scientists to an Art

Spelman College will go to great lengths to make sure its students succeed, even turning to the silver screen. With a portion of its $1.4 million grant from HHMI, student filmmakers at the Atlanta college will create a full-length documentary film examining the lives of recent Spelman graduates who are now pursuing successful scientific careers.

The movie is just the beginning of a larger effort to highlight successful scientists who may serve as an inspiration for science majors at the school. Spelman, which was founded after the Civil War to educate African American women, is completely revamping its mentoring program in the biological sciences with the HHMI funds.

"The film will focus on lifestyle choices Spelman graduates have made as scientists and as women struggling to balance their work lives and home lives," said biology department chair Cynthia Bauerle, Spelman's HHMI program director. "We hope the movie will speak to young alumnae who are struggling with the same issues and help keep them in the field." Production will begin in fall 2008, and the film should be ready by early summer 2009.

The mentoring program will also pair successful Spelman alumnae who are pursuing careers in science with female Atlanta high school students who are interested in science. The hope is the mentors will encourage students to maintain their dreams and passion about science as they begin thinking about and enter college. Spelman will provide training for its alumnae mentors on strategies to help the high school students make the transition from high school to college. When the college informed its biology alumnae about plans for this mentorship program, it received more volunteers than it could handle. Bauerle hopes the program can eventually expand to include all the alumnae, who are eager to participate in this project.

Every summer, a large number of Spelman students conduct research off-campus at other universities. The college will add a new facet to its mentoring program by placing its students in the labs of top minority women scientists at research universities across the United States. "We sought out established female minority scientists around the country, and every one we contacted agreed to take a Spelman student into their labs in the summer," Bauerle said.

The college will also use its grant to hire a new microbiology professor, create more genomics courses, and develop interdisciplinary science classes. "We want to link biology to other areas of science," Bauerle said. "We think this is critical because many biologists today work closely with colleagues in other fields. We need to prepare our students to take their place in the world outside our walls."

SWARTHMORE COLLEGE

Expecting Excellence, Providing Support, Works for Swarthmore

Four nights a week, teams of Swarthmore College students get together to puzzle over the scientific problems that their introductory biology professors have presented. Guided by juniors and seniors who've successfully navigated the introductory courses, these voluntary study groups have been wildly popular among students and faculty alike.

First offered in 2005, the study groups help students acquire crucial study skills, excel in class and learn to work together. At Swarthmore, the study groups have also increased the number of students who continue on to upper level science courses—particularly students from underrepresented minority groups. The program's success in the biology department encouraged Swarthmore to expand; the college will use part of its $1.6 million HHMI grant to extend the program to introductory courses throughout the Division of Natural Sciences and Engineering.

"The study groups facilitate the kind of collaborative learning that is typically absent in a large lecture course," says Kathleen King Siwicki, professor of biology and HHMI project director. "And, the program makes students feel like they have a home in the biology department."

Siwicki says the program is successful, at least in part, because it is voluntary. Students attend the sessions to solve challenge problems—assignments given by professors to help students prepare for biweekly quizzes. Snacks sweeten the deal. The result is that more than half of the students in introductory biology choose to attend at least one of the study groups every two weeks. Many students attend more frequently.

"We are setting the standard quite high with these challenge problems. They aren't easy for even the most expert students," Siwicki notes. By assigning difficult problems that are best solved collaboratively, encouraging group work, and providing upper-class mentors, Swarthmore can provide both demanding exercises and the support necessary to ensure that students succeed.

The program is particularly effective for students from traditionally underrepresented groups, including first generation college students. "Many students from underrepresented groups simply lack the confidence to ask a faculty member for help," Siwicki says. "The challenge problems provide an opportunity for them to learn from their peers, develop strategies for tackling difficult scientific problems, and become more confident in their own abilities . It also models the importance of collaboration in science and builds a social network around challenging academic work."

TRINITY UNIVERSITY

Stepping on Campus Reveals a Whole New World

Using part of a $1.5 million HHMI science education grant, Trinity University plans to invite hundreds of middle school students from the San Antonio Independent School District to campus to learn what it is like to be a scientist.

The college's program will bring 200 7th graders to campus from four inner city San Antonio schools that have high numbers of Latino students. Students will visit Trinity once each quarter for day-long workshops that tie in with their school science classes. A fourth workshop will include an overnight stay and ecology field research at Bamberger Ranch, a 5,500 acre facility that hosts one of the largest habitat restoration programs in Texas. During these workshops, pairs of students—with guidance from their teachers and Trinity science students and faculty—will be encouraged to come up with their own questions to research, based on what they have been learning in class. Past projects have included studying the types of bacteria that grow inside football helmets—and the best way to eradicate them, the feeding behavior of fish species at Bamberger Ranch, and the effects of sports drinks on exercise activity in mice.

At the end of the year, each student will prepare a poster detailing his or her favorite project from the Trinity program, and the university will host a poster reception for students and their parents.

"We want to involve parents," said Mark R. Brodl, George W. Brackenridge Distinguished Professor of Biology and program director for the HHMI grant. "In Latino communities, having parents understand what college is about is an important influence on whether students go on to college."

Trinity is developing another HHMI-supported outreach program, the Science Curriculum Writing Institute, that brings teachers from throughout the San Antonio school district to campus for a week during the summer. Teachers will work with Trinity science and education faculty members to build science curricula that make the most of limited classroom time.

"We've found in previous projects that these teachers' time constraints in the classroom are significant," Brodl said. "They have a huge amount to do in very little time, so they have to be efficient."

In addition to these initiatives, Trinity is adding a neurobiophysicist and a specialist in science education to its faculty. The school is also expanding its summer research program for undergraduates and has earmarked two student fellowships for research abroad with HHMI international research scholars.

UNIVERSITY OF LOUISIANA AT MONROE

Outreach Focuses on Rural Louisiana Schools

Most high school students in northern Louisiana have never conducted a hands-on science experiment. Using part of a $700,000 grant from HHMI, the University of Louisiana at Monroe is trying to change that by bringing high school science teachers and students to campus for a summer science program that emphasizes discovery and hands-on science.

The college is expanding the program, which currently has space for about 50 students and eight teachers. Every spring the university receives hundreds of applications —and there is too much demand for too few spaces in the program. "Many of the students are interested in science, but their only context is that they want to be a doctor," said Ann Findley, a biology professor and program director of the HHMI grant. "Here they get an idea of what it's like to do real science."

One week there might be a "crime scene" to evaluate in the lab, which introduces students to DNA testing and forensic science. Another week students might take plant samples from farm fields and grocery stores and then analyze them in the lab to see if any of the plants have been genetically modified.

About 30 to 35 percent of the students in the program go on to become students at the university, Findley said. Not all become science majors, "but even the ones who go into business or liberal arts are informed by their science background," she said. "Their interests tend to be interdisciplinary."

Teachers who have been through this summer program can borrow lab kits that include equipment and supplies that allow teachers to recreate the program's experiments in their classrooms. "By going out into the schools through these alumni teachers, we can reach many more students" than possible with the summer program, Findley said.

Faculty members also visit local schools to do large-scale, day-long demonstrations, such as isolating DNA. "Students come in, and then leave with a little tube of their DNA," Findley said. "They love that. It's very important for students, whether they study science or even go to a university, to at least get a context in which to put their science instruction."

The university is also using part of its grant to start a mentoring program with Monroe's Ouachita Parish School System. Science faculty members and graduate and undergraduate students will participate in tutoring programs for middle school and high school students. Faculty members also will serve as mentors for high school teachers with advanced placement science courses.

UNIVERSITY OF PUERTO RICO, MAYAGUEZ

Island Campus Reworks Biology Curriculum to Incorporate Research

With 1,300 undergraduates enrolled in biology courses at the University of Puerto Rico at Mayaguez, the faculty was overwhelmed trying to provide hands-on research opportunities for students. Thanks to a new $1.4 million HHMI science education grant, project director Nanette Diffoot believes they are headed toward a possible solution.

"Our special research course only reached 100 students a year, so we decided to use our entire 2008 HHMI grant to restructure regular courses in the curriculum to include short research projects and teach laboratory skills," Diffoot said.

The university's courses in general biology, genetics, botany, zoology, microbiology, immunology, and cell biology all have laboratory components that contain an average of 13 exercises per semester. The new curriculum will pare down these exercises and use the freed time to allow students to create and carry out short research projects. These projects will focus on plants and organisms native to Puerto Rico, including local cassava, invertebrates, and microbial habitats.

"We're starting with the basic classes and working our way up the curriculum," Diffoot said. "All our science majors should have more than one research experience before they graduate."

Choosing the subject of their research and designing experiments will increase students' critical thinking and problem-solving skills and help them become acquainted with current scientific issues. Students will gain firsthand experience with many of the tools that drive today's foremost scientific research: protein and genome fingerprinting, digital scientific imaging, plant tissue culture, bioinformatics, and modern molecular genetic practices.

Students that participate in these research projects will generate data and insights that will merit future publications in journals, on the college's web site, and in local and national educational presentations.

The university's new approach to its biology curriculum will begin with its courses, but will eventually expand into other programs. For example, high school teachers, undergraduates in the biology teacher training program, and adjunct professors who teach beginning and intermediate undergraduate courses will learn about local research projects that will enhance their curriculum.

"Through HHMI, we hope to enrich the lives of our college students and the high school students on our island in ways that weren't possible before." Diffoot said.

UNIVERSITY OF RICHMOND

Computational Tie Binds Interdisciplinary Classes

If you want to see the big picture in science, you've got to learn to crunch the numbers. That's a theme at the University of Richmond, where faculty funded by a $1.4 million HHMI grant are teaching computer science in their introductory science courses.

"We've found that students who don't have at least a rudimentary background in programming are at a real disadvantage," says HHMI grant director Kathy Hoke, a mathematician. "The ties that bind disciplines tend to be computational."

The faculty at this Richmond, Va., institution aim to expose students to computer science and more in a new, two-semester course that replaces standard introductory classes in computer science, biology, chemistry, physics, and math. Instead of learning these subjects in isolation, students will approach them in an interdisciplinary way. Students will use their programming skills to investigate pertinent science questions, such as modeling key HIV proteins and analyzing their ability to bind to inhibitory drugs. That class will prepare students for upper-level courses in each field, which they can pursue from their sophomore years onward.

"We want our students to think algorithmically," Hoke explains, saying it will better prepare the students for a career in science. "And we'll structure the class so they learn to answer questions like this by drawing from different perspectives, such as molecular biology, thermodynamic analysis, and mathematical modeling."

The emphasis on computation is also reflected in newly-offered courses in bioinformatics, biophysics, computational science, neuropharmacology, and systems biology. Hoke says these subjects all combine elements from multiple fields; progress in each one is dependent on the use of databases and quantitative methods. Systems biology, for instance, draws heavily on genomics and molecular biology, which are data-intensive fields.

The same can be said for epidemiology, which looks for medical trends in human populations. Using its HHMI grant, Richmond is adding a new faculty member in epidemiology this year. "Epidemiology draws on multiple disciplines, and it's an area that we currently don't have expertise in," Hoke says. "And we've found that questions about disease really engage students from a variety of different majors."

UNIVERSITY OF TEXAS-PAN AMERICAN

Texas University Takes Lab to the Sagebrush

The University of Texas-Pan American is about as far south as you can get and still be in the United States. This rural area that hugs the Mexico border is growing fast, but towns are far apart, and many of the school districts have little money.

This makes it almost impossible for the university to bring the local community in to meet scientists in their labs. So the Edinburg, Texas, university is using part of its $1.2 million HHMI grant to take its research expertise on the road in an attempt to get middle school students excited about science. "Many of the schools are far away and poor and couldn't afford to get their students to our campus for outreach programs, so we take the campus to them," said Hassan Ahmad, the college's HHMI program director.

To take the campus to the people, the university has converted a 40-foot bus into a mobile lab. After pre-lab classes to give the sixth through ninth graders background on what they will do, the students suit up in white coats and goggles and perform experiments at one of 22 lab stations. All the projects apply to the real world: screening a patient for sickle cell anemia using the real gel tests used to diagnose the disease; testing hypothetical patients for HIV infections using real virus detection assays; performing DNA analyses on simulated crime scenes; and looking at their own DNA under a microscope. "We got the money for the bus from our 2004 HHMI grant, but it took us two years to get everything ready," said Ahmad, who is chair of the university's chemistry department. "Since 2006 we've worked with 9,275 students and 196 teachers at 87 schools."

The purpose of the bus is to rev up the kids' passion for science, but Ahmad and his colleagues know if their project is to succeed, the excitement needs to be sustained long after the bus pulls away. So he has a backup plan: Although it is impossible to give local teachers enough training in the two days they are on site, UT-Pan American is also using some of its new HHMI funds to start a teacher training program. The summer program will bring six educators to campus every year for eight weeks to work on a research project they develop with a faculty mentor. The teachers will also create lessons and exercises they can take back to their classrooms.

"We love the new culture of research HHMI has helped us create on our campus, but some of us would rather sneak away on the bus and ride the range, waving microscopes instead of branding irons," Ahmad said. "It's so much more fun!"

VASSAR COLLEGE

Grant Buys Time for Faculty to Rebuild Curriculum

Vassar College's new $1.5 million HHMI grant will pay for many things—lab materials, student stipends, bio-imaging systems, and even yellow buses to bring elementary school children from Poughkeepsie, N.Y., to the campus ecological research station. But what the college most wants to buy is time, according to Nancy Jo Pokrywka, a cell biologist and program director of Vassar's HHMI grant.

Vassar views this as an opportunity to make critical improvements in Vassar's science curriculum, especially bringing the computational and biological sciences closer together. The grant will release the science faculty from teaching commitments to pursue new training and new skills. The funds will also free the faculty for collaborations between Vassar scientists so they can work out new interdisciplinary approaches to curriculum and to research. To aid in implementing these plans, Vassar will hire a Scientist-In-Residence, an early-career researcher already trained in an emerging cross-discipline approach such as proteomics or computational modeling who can pass on his or her skills to the faculty while gaining experience in teaching at a liberal arts college.

Vassar believes that early exposure to real research problems in a real lab is the best science preparation for all undergraduates. Under a new program, students from underrepresented groups will be brought to campus early as "pre-freshmen" the summer before they enroll. The pre-freshmen will be paired with upper-class mentors participating in Vassar's already successful summer research institute. During the regular school year, HHMI money will allow the research experience to continue by covering the teaching time of science faculty who will lead small groups of six or more students engaged in joint and individual projects.

The HHMI grant will buy time for science outreach on-campus as well, Pokrywka says, especially at Vassar with its long tradition as a liberal arts institution. A series of special programs will introduce non-science majors to scientific thinking and engage them on issues such as global warming or the bioethics of human reproduction. Off campus, it will fit time into the schedule for students to work with science teachers in local schools.

WASHINGTON AND JEFFERSON COLLEGE

Students Turn High-Tech Tools on Forest Research Station

Not far from the campus of Washington and Jefferson College lies a 57-acre parcel of land that is home to a deciduous forest, a conifer stand, wetlands, perennial streams, salamanders, fish, white-tailed deer and assorted wildlife. The site is an outdoor classroom for students who make the 5-mile trip to do research at the school's Abernathy Field Station, where researchers from the college have established long-term projects to monitor the local ecology.

Now, with funding from a $1 million HHMI-grant, the faculty and students at the Washington, Pa., school will be able to develop and use the latest molecular methods to study ecological changes at the genetic level. "We want to incorporate these methods into our long-term ecological monitoring efforts, "explains HHMI program director Alice Grier Lee, a biologist.

Scientists can use global positioning systems, as well as ecological and molecular methods, to track how ecological disturbances influence wildlife physiology over time, Lee says. They might use global positioning to study patterns of behavior of species and microarrays to study how the expression of specific genes in birds changes in response to climate fluctuations.

The college will spend some of the HHMI funds to hire a postdoctoral fellow to work with faculty and students to create a database for the long-term ecological monitoring. The fellow will in turn, will gain experience teaching and working with students on biological research projects. The school is also creating a tenure-track position for someone who has expertise in both molecular methods and field-based tools like global positioning systems, to enhance links between field work and lab-based research, Lee says.

Bioinformatics will be a large part of the school's new ecology program, since it will be an essential part of collecting and analyzing molecular information. The faculty plan to develop new courses in bioinformatics and computational biology to train students how to work with this data and support students summer research programs in bioinformatics and other areas. As the monitoring studies move forward, the faculty plan to develop a Web-based clearinghouse for molecular ecosystems data and create a portal that will connect the college's investigations with broader research efforts elsewhere.

Apart from growing the college's molecular capabilities, Lee says the new HHMI funds go a long way towards supporting ongoing ecological monitoring at Abernathy Field Station, which relies on new equipment, laboratory facilities, and research stipends. The transition towards new increased molecular capabilities will benefit students and faculty alike, Lee says.

WASHINGTON AND LEE UNIVERSITY

University Is Moving Biology into the Quantitative Era

Washington and Lee University is using part of a $1.3 million HHMI grant to transform how it teaches biology to ensure that its students and faculty are prepared to participate in the new era of biology exemplified by the burgeoning fields of genomics, proteomics and neurobiology.

"It's been easy to be purely descriptive in biology," says Helen I'Anson, professor of biology and neuroscience and HHMI program director for the Lexington, Va., school. "However, at the forefront, it is more of an applied science that uses physics, chemistry, and mathematics to describe a moving, changing system of many parts. Our goal is to retool and retrain the department by introducing the quantification of biology so that we can move to the next level."

Washington and Lee will focus on developing its faculty and updating its curriculum to include quantitative and computational approaches in biology. The school will hire two new faculty who have expertise in computational biology and a subfield of biology—like neurobiology, molecular biology, or physiology—that relies heavily on computational methods to understand data. The new faculty members will work with current faculty to incorporate quantitative and computational exercises into existing courses and develop new interdisciplinary courses.

"By virtue of the fact that we are trying to be more quantitative in our approach we will become more interdisciplinary," I'Anson says, noting that computer science and math are a given in most interdisciplinary courses. The faculty and students will take their appreciation and understanding of the quantitative nature of science to elementary schools in the Lexington area. An outreach program that runs during Washington and Lee's shortened spring term has faculty and undergraduate students developing laboratory exercises for elementary students that meet Virginia's educational standards. The students then go out and teach the laboratory exercises.

"This program is really exciting not only because we can reach so many elementary school students, but because it fits really well in our curriculum and faculty development," I'Anson says. "If you can't teach grade school children about using math to explain biology, you don't really understand it yourself."

WELLESLEY COLLEGE

Wellesley Makes a Triple Play for Science

Junior faculty members at liberal arts colleges often have a hard time getting experienced help in their labs. Postdoctoral fellows are cautious about coming to a lab that is not well established, and getting federal grants that pay for technicians has become more difficult in recent years. At the same time, students often aren't ready to go directly to graduate school after graduation. They may take a year off to decide on their specialty or earn some money before beginning a doctoral program.

Wellesley College hopes to address both problems and make its labs a better place for students with part of its $1.2 million HHMI grant. Each year, the school will hire one or two graduating seniors to stay an extra year as a research assistant. They will be paid to work on projects related to the faculty member's research, and at the same time they will mentor undergraduates.

"The students will make big progress and get a paid year off between college and grad school. The junior faculty will get the help they need, and the new students will be mentored by recent graduates, with whom they won't be ashamed to admit mistakes, says biology professor Barbara Beltz, project director of Wellesley's HHMI grant. "We'll help three groups of people through a challenging period in science nationally, and have a lot of fun in the process."

The mentoring component of the program will potentially help dozens of undergraduate students, since the college's HHMI grant supports 75 summer science students, who will get 10 weeks to delve into their research without juggling the demands of a full course load.

In addition, the HHMI grant will formalize the college's outreach efforts under a paid coordinator, purchase new equipment, and revive its curriculum development fund, which encourages faculty to develop new courses and enhance existing ones by offering summer support.

WESLEYAN UNIVERSITY

Dancing The Scientific Classics Leads to Better Learning

Gregor Mendel founded the science we of genetics, but it took biologists at Wesleyan University and choreographer Liz Lerman to bring the scientist-monk and his work to the dance stage. Mendel's dancing double was a central character in the 2006 world premiere of Lerman's "Ferocious Beauty: Genome," a multimedia dance and theater event that electrified the Wesleyan campus audience. Now "Genome" is back for a modified encore presentation. It will be used as an educational gateway into cutting-edge bioscience, one part of Wesleyan's wide-ranging approach to teaching science using part of a $1.4 million HHMI grant.

Wesleyan's previous HHMI grant in 2004 sparked the Lerman dance collaboration, but the new grant will capitalize on its success, according to Michael Weir, a biology professor and director of the new program. By repackaging "Genome" into web modules that include video clips from the performance, commentary from the choreographer, dancers and scientists, and suggestions for dance movements that can be practiced in the classroom, Wesleyan hopes to use it as an outreach tool to engage middle and high school students and their teachers. The new grant will also bring Lerman and her colleagues back to campus for workshops and a two-day symposium tied to Wesleyan's summer undergraduate research program.

Dancing science, or as Weir describes it, "embodied learning," is part of Wesleyan's strategy to break down traditional disciplinary boundaries and make the understanding of science and research central to undergraduate learning. Dancing may be a good way to get people interested in science and to explain basic concepts, but Wesleyan believes that nothing grabs a young scientist's interest like the direct experience of inquiry in the lab. Stepping into research is also the best way to keep underrepresented minority and women students in science. The HHMI grant will support 27 more undergraduates, including outreach students, in Wesleyan's summer research program. During the regular school year, the HHMI grant will allow students to be paid their work-study stipends for hours spent in the lab on their research projects.

Even with dancing to draw them in, and a strong undergraduate research program and close faculty mentoring to keep them, students still have to survive the shock of first-year "gateway" courses, which are often particularly rough on women and minorities. The new HHMI grant will test two approaches to the gateway problem—standard three-hour introductory survey classes supported by a fourth hour devoted to developing study skills, versus a new "alternative pathway" that will feature smaller classes concentrating on problem and theme-based learning. The students' academic outcomes in the two tracks will be closely followed.

WHITMAN COLLEGE

New Facility Brings Three Disciplines Into One Lab

What better way to make progress in science than by tearing down the walls that keep scientists apart? Funded by an $800,000 HHMI grant, Whitman College is creating a new laboratory where students in biology, physics, and computer science can work together on shared problems.

The new laboratory at the Walla Walla, Wash., college will let students and faculty link tools for informatics—a field that analyzes and makes sense of data—with analytical instruments like spectrophotometers and x-ray diffraction tools that reveal the inner worlds of proteins and other biological molecules. Instead of bouncing from the computer lab to the lab bench, students will transition seamlessly from one to the other in one place. That ability will help them hone the skills they need to succeed in the life science workforce and in graduate school, says HHMI program director James E. Russo, professor of biochemistry.

Students will learn, for example, how to create molecular structures in the laboratory using designs generated by computer software. Or they might learn how to create the right conditions for a genetics experiment by accessing information contained in online databases. "It's crucial that our students learn how to design experiments using computational information," Russo says. "The new lab facility will allow our students to access that information in real-time. That's the model for biomedical research at major universities, and we want to apply it here at the undergraduate level."

Through a separate, HHMI-funded collaboration with the Fred Hutchinson Cancer Institute in nearby Seattle, students will also be able to work with some of the top biomedical scientists in the world. A newly-hired Whitman faculty member in bioanalytical chemistry will also be on hand, teaching courses that focus on detecting biomolecules and determining their structures. "That's an area of expertise missing in our curriculum so we're looking forward to having this new individual on board," Russo said.

Russo emphasizes that Whitman has a history of multidisciplinary science education, which HHMI began supporting with its biochemistry, biophysics, and molecular biology programs back in 1990. The new grant strengthens the school's commitment to breaking down barriers in traditional disciplines, he says.

WILKES UNIVERSITY

Disease Dynamics Makes Science Global for Students

Wilkes University seeks to turn students into scientific sleuths who use a background in ecology and computer mapping to tackle emerging problems of global proportions. Their target? New emerging pathogens and disease in unexpected places with unforeseen consequences.

As worldwide travel becomes more prevalent and global warming changes where pathogens live, there is a pressing need to fill in the gaps of our understanding of the microbes, parasites, and other pathogens that inhabit our world. The college will attract students to this effort with their $1 million HHMI grant.

"Epidemiology and disease ecology—the areas of science that deal with the dynamics of emerging diseases—are fascinating fields," said Michael A. Steele, director of the new HHMI program and chair of the biology department. "Our students will need many new skills to detect and predict the course of plant, animal, and human diseases as they evolve, and we will use our grant to help them do so."

Wilkes has created an action plan to build student knowledge and skills in critical areas. The first step is to increase their math and computer skills to enable them to tackle big problems, for example, assessing movement of disease in the environment. The university will hire two new faculty members who work at the interfaces of biology and physics and biology and mathematics to help make courses in physics and mathematics more relevant to the life sciences.

Then the Wilkes-Barre, Penn., college will teach students to use Geographic Information Systems (GIS), so they can determine how far a disease has spread, predict how fast it could move across a region, and track the species that could harbor the pathogenic organism. The university's environmental science department already has a GIS center, and it will be modified for use with the biological sciences.

The ultimate way for students to prepare to address real-world problems is to directly tackle questions that require creative, interdisciplinary solutions. Wilkes will also use its HHMI funds to develop super labs, which will provide students with the opportunity to immerse themselves in a single research problem for 10 days between their sophomore and junior years. Each class will choose a real problem in cellular or molecular biology, ecology, or marine science and design experiments to answer crucial questions. The short super lab will allow the students to develop skills in experimental design and advanced laboratory and field techniques, which prepares for more in-depth research in their junior and senior year.

The HHMI grant will also fund collaborations with other scientific institutions, support more undergraduate research positions at Wilkes, and strengthen and expand a program that brings middle-school girls to the campus to spark their interest in math and science.

"We must hook these potential researchers, and this program gets them over the middle school gap where many girls are lost from the sciences," Steele said.