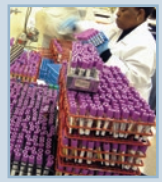
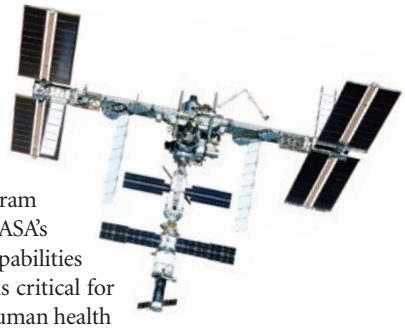
p1125 Last words: Colin Blakemore ponders the fate of UK medical research.

p1128 Sharp focus: Indian nonprofit makes cheap microscopes for schools.



p1131 Life savers: Simpler tests for CD4 cells could help AIDS clinics.

Amidst doubts, space research program takes flight



Given that all life on earth evolved in the presence of gravity, not all scientists agree that research in space can reveal anything informative. Nonetheless, a few researchers are eager to blast off their cell cultures, hamsters and pathogens into orbit.

On 12 September, the US National Aeronautics and Space Administration (NASA) and the US National Institutes of Health (NIH) launched a joint plan to encourage biomedical research in space.

"The [space] station provides a unique environment where researchers can explore fundamental questions about human health issues—including how the body heals itself, fights infection or develops diseases such as cancer or osteoporosis," NIH director Elias Zerhouni said at the announcement on Capitol Hill.

But closer examination reveals that the project does not come with any new money to fund research. NASA is offering up room for experiments on the International Space Station, a 14,000-cubic-foot facility that orbits 220 miles above the earth and is shared by Russia, Japan, Canada, Brazil, the US and Europe. The expense of NIH projects in the station, including the high costs of getting equipment and materials there, will have to be paid by the NIH.

NASA's own funding for basic research nearly dried up three years ago, when President Bush called for a new focus on expeditions to the moon and to Mars. After the shuttle Columbia blew up in 2003, NASA also cut back the number of planned flights to the space station and cancelled several pieces of scientific equipment intended for the station, including a large centrifuge module planned by Japan. As a result, the agency is leaving unused some 22 cubic-meter racks set aside for science experiments.

Because there is no new money in the deal, the agreement might not lead to much new research, notes Keith Cowling, a former space station program manager and gadfly blogger.

"It is somewhat hollow given the current state of the space station," Cowling says. "The space station has profound potential that has not been tapped and may not be tapped."

In the mid-1980s, when NASA was trying to convince the US Congress to fund a space station, the agency estimated that it would cost $8 billion and be complete by 1994. Two shuttle disasters and more than $25 billion dollars later, the new date for completion is 2010.

The European Space Agency and the Japanese Aerospace Exploration Agency have built their own research modules for the space station, both of which are waiting to be flown up and attached. In the meantime, the European agency on 14 September launched the Foton microgravity mission, which is carrying, among other things, 26 baby cichlid fish that will have their inner-ear development monitored as they grow in microgravity.

Matt Hansen

Empty promises? There's no new money to fund biomedical research in space.

"It may well be that the US paid the lion's share of the construction of the [international space station] and got the smallest amount of direct science return," says Cowling. "That's a shame."

NASA's research funding is focused almost completely on studying the deleterious effects of spaceflight on people. The problems are not trivial: serious bone density loss, ionizing radiation and even the psychological strain of prolonged isolation plague astronauts.

"The station is our space biomedical research laboratory," says Steve Davison, program executive in NASA's Advanced Capabilities Division. "It is critical for us to assess human health space risks."

There are also a few experiments underway in more basic biology. For example, *Salmonella typhimurium,* which causes foodborne illnesses, is more virulent in space than it is on earth. And cells grown in a liquid culture in microgravity do not huddle against the plastic, but float in a bath of low fluid shear forces, not unlike that found in certain compartments in the body, such as the villi of the respiratory tract.

Although many people, including scientists, question the advantages of research in space, "We know that a lot of our knowledge has been gained from testing biological systems at their extremes—pH, temperature and so on," says Cheryl Nickerson, a biologist at Arizona State University in Tempe, who works on the *Salmonella* project. "Every time we do this, we find out something new about how systems and cells do the things [they] do. We are looking at pushing a system to another extreme now."

Playing with those extremes will be an expensive endeavor, however. Because the aging fleet of space shuttles is scheduled to be retired at about the same time as the space station is complete and ready for experiments, the experimental racks will have to catch a ride either with the Russian space shuttle, with as-yet unbuilt systems from Europe or Japan, or with NASA's planned Orion crew vehicle, which the agency hopes to launch in 2014.

According to Mark Uhran, assistant associate administrator for the station, the preferred vehicles are likely to be space transportation services run by private companies. "The space station has been in the construction phase so we have not initiated the research program in earnest and will not until it is complete," says Uhran. "We think the timing is just about right three years in advance to get people thinking about this."

Emma Marris, Columbia, Missouri

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Poor trial design leaves gene therapy death a mystery

The gene therapy trial during which a 36-year-old Illinois woman died in July was inappropriately designed, experts said at the 17 September meeting of the government panel investigating her death.

Researchers affiliated with Seattle-based Targeted Genetics injected a gene therapy treatment into Jolee Mohr's right knee first in February and again on 2 July. On 24 July, Mohr died.

The immediate cause of her death was massive bleeding behind the kidneys from unknown causes, which led to the collapse of multiple organs. Her body was also overwhelmed by a fungal infection known as histoplasmosis, which can kill people with deficient immune systems.

Mohr had also been taking Humira (adalimumab), an injectable protein that eases the symptoms of rheumatoid arthritis throughout the body by blocking a protein called TNF-alpha. The gene therapy product being tested also blocks TNF-alpha, but it was expected to do so only in the affected knee.

"The study was poorly designed. If you're trying to test safety of a product, then by definition the person shouldn't be allowed to be on [another medicine in] that same class of product," Kyle Hogarth, a critical-care doctor at the University of Chicago, where Mohr died, told *Nature Medicine* after the Recombinant DNA Advisory Committee meeting. "What made her sick? Was it the Humira she was on or the gene [therapy] product? We'll never know."

There is no test proven to distinguish between the two medicines, although a test made by California-based Amgen may be able to do so. Both drugs suppress the immune system, and if the gene therapy product leaked out of the joint it may have tipped a precarious balance, allowing the fungal infection to overwhelm Mohr.

"If you don't have an assay, don't do the trial—that's my sense," Hildegund Ertl, who directs the Vaccine Center at The Wistar Institute in Philadelphia, said bluntly at the meeting.

These criticisms are off the mark, counters Stewart Parker, president and chief executive officer of Targeted Genetics. It is "good clinical practice" for people to be maintained on the medicines they are already taking when investigators introduce an experimental drug, Parker says. "If patients were denied current therapy, that would be considered unethical, as there is no guarantee in a safety study that benefit will be observed."

The purpose of local injection of the gene therapy is to treat joints that are unresponsive to injected proteins that affect the whole body, Parker adds. To treat resistant joints, she notes, "One would have to give massive doses of systemic therapy, which would lead to serious, significant side effects from systemic immunosuppression."

Meredith Wadman, Washington, DC

Karolinska Institute under fire for controversial cancer report

It's no surprise that access to new cancer drugs varies from country to country. But can this discrepancy be to blame for poor survival rates in some countries?

A controversial report from Sweden's famed Karolinska Institutet, which claims that access to the newest cancer drugs enhances survival, has triggered a spat between the report's authors and experts who say the report's conclusions are based on faulty analysis.

The report, first published in 2005 by the institute and updated in a June supplement in the *Annals of Oncology*, includes a chapter that examines the impact of a drug's 'vintage', the year it is first launched, on cancer survival in five European countries and concludes that cancer patients with access to the newest drugs live longer (*Ann. Oncol.* **18**, iii1–iii77).

Michel Coleman, professor of epidemiology at the London School of Hygiene & Tropical Medicine, says the researchers' methods are so flawed that the report should never have made it past the peer review process. "Just because the Karolinska institute is famous doesn't mean that everything that's published with its name on it is necessarily correct or laudable," he says .

In the same journal's September issue, Coleman points out that the report was funded by pharmaceutical giant Roche and lambasts the authors' methods (*Ann. Oncol.* **18,** 1433–1435). For example, Coleman questions the report's use of survival data from the early 1990s and drug access data from 2002 on. "How in the name of heaven can you draw any kind of causal conclusion that survival is somehow the result of the access to the drugs when the latter postdates the former by ten years?" he asks.

Heather Stone/*Chicago Tribune*/MCT

Quality of care: Can access to the newest cancer drugs improve survival?

The UK's National Institute for Health and Clinical Excellence, the agency responsible for deciding which new drugs should be provided by the government, also publicly rebuked the authors. "This drug industry–sponsored report is flawed, inaccurate and directly contradicts itself in places," Andrew Dillon, the agency's chief executive, said in a statement in May.

Ulrik Ringborg, director of Karolinska's Cancer Center, would only say that the chapter has "tremendous methodological problems". "I cannot say they are wrong, I cannot say they are right because the methodology is not perfect."

The primary author of the controversial chapter, Columbia University economist Frank Lichtenberg, says the strong relationship between survival rates in different countries and drug vintage makes the conclusions more persuasive. "I quite frankly don't think that Coleman understands the techniques that we're using," Lichtenberg says.

Lichtenberg says he isn't surprised by the backlash, which he sees as a knee-jerk response. "Many people are highly critical of the pharmaceutical industry and anything that sounds like a positive message about the role of the pharmaceutical industry in society," he says.

Isabelle Durand-Zaleski, a health economist at the Hôpital Henri Mondor in Paris, notes that speedy drug access could be a marker of other factors that prolong life, such as better diagnostic facilities or a country's overall willingness to deal with disease. But the important thing, she adds, is that the debate will inspire more research.

Coleman couldn't agree more. "Critique is the substance of science," he says. "We'd never get anywhere if we all believed everything we saw in print."

Cassandra Willyard, New York

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Straight talk from... **Colin Blakemore**

After four years at the helm of Britain's Medical Research Council (MRC), which governs a £530-million research budget, Colin Blakemore is stepping down. As *Nature Medicine* went to press, a successor had not been formally announced. Here Blakemore talks about his tenure at the agency, the future of British medical research and the community's fears over the council's new 'translational' agenda, proposed by the government's 2006 Cooksey Review, which recommends shifting the focus to more applied research.

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What do you see as your main achievements during your tenure?

Shortly after I came in, I argued that there was both a moral obligation and a scientific opportunity to find new ways of exploiting discovery more effectively. If we had not made that commitment, and hadn't done a lot of thinking about where we can best contribute to translational research, then I think the MRC would be in a much more difficult position than it is now.

Funding for universities has virtually tripled during my time at the MRC. Although our award rate is still low (about 20%) compared with those of most other British research councils, it's considerably better than it was four years ago, despite the fact that the number of grant applications to the MRC has just about quadrupled in some areas. Something that I set as a target, and which seems to have been achieved, is that all the research boards are now funding all of the applications that they rate as being internationally competitive. When I came in, some boards were funding less than 50% of such applications, which was just an unacceptable situation.

Why has there been so much mistrust of the Cooksey review?

The most important thing to say is that the MRC should—and I think will—maintain the quality of its judgement in supporting the very best of biomedical research in the UK. The fear that's been in the air over the past year has been about whether funding might shift toward applied research at the expense of the kind of fundamental research that's been done so brilliantly in the past.

I wouldn't say everything's certain, because there's an awful lot to be worked out in detail, but I'm a lot more confident than I was six months ago that the MRC will retain its full commitment to fundamental research. Cooksey says very clearly that the funding for the underpinning basic research must be sustained, and we are all hoping, of course, that this means genuinely sustained.

How much can researchers expect the MRC to change?

I don't anticipate an abrupt change—and you can see the precedent for all the likely changes in the MRC's strategic thinking over the past four years. Actually, the MRC has always done a much better job of integrating nonclinical and clinical research than most of the funding agencies in the world. I know from visiting other places that we are the envy of the world in our capacity to cover the whole spectrum of medical research. Others are just now thinking about how to put together clinical and basic research and [are] finding it very hard—well, the MRC's been doing that since 1913.

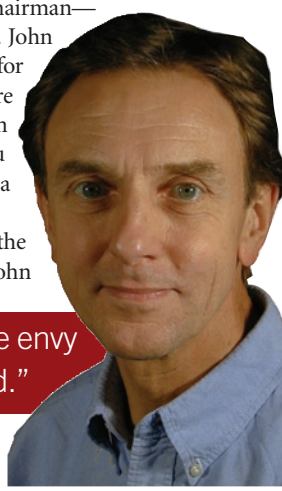
Why did you decide to leave now, and what are your career plans?

The next few years will see new challenges and opportunities for the MRC—and that means that it will be good to have a different viewpoint, someone else with new ideas. There's never an ideal time to leave a job, but from my own point of view, leaving now is good for my future. I'm 63, so it would have been difficult to start something else really challenging if I had spent two or three more years at the MRC.

I'll be doing a varied portfolio of different jobs. I'm going back to a professorship at the University of Oxford, and I'm also taking an appointment at Warwick as a professor of neuroscience, which will include the possibility of establishing some kind of collaboration in Singapore, where I shall also hold an appointment, helping to increase activity in neuroscience.

How do you interpret criticism that John Chisholm, who was appointed to preside over the search for your successor, is too hands-on?

You have to understand how nervous the research community is at present about possible threats to the MRC. Almost anything that happens—my leaving, the commitment to translation, a new chairman—provokes all kinds of suspicions and interpretations. John Chisholm is a distinguished engineer with a reputation for robust commercial management . So some people were inclined to think that the MRC was going to be driven in a much more applied, goal-oriented direction. But you have to see some of this reaction as an expression of a more general concern about the future of the MRC.



"We are the envy of the world."

I'm very confident that the next chief executive of the MRC will be strongly supported by John Chisholm. John will be strongly involved in helping the MRC to implement its plans, but I don't think he will try to drive the scientific thinking of the MRC.

One of the main controversies of your tenure was the proposal to move the National Institute for Medical Research (NIMR) to central London from its suburban site at Mill Hill.

NIMR is a wonderful place to work and it's a well-organized and supportive community doing excellent research. But it's geographically isolated and lacks close association with the wide range of other disciplines, including clinical science, which will be essential for biomedicine in the coming decades. I was disappointed with the strength of opposition at the institute to the plans for a move. They seemed not to acknowledge fully the changing, broader agenda for medical research, or the fact that the institute is entirely owned by, and responsible to, the MRC. It's not an independent entity that just has the right to draw its £35 million a year and make its own decisions.

The bottom line is, it must be the Council of the MRC that determines what happens to its investments and what is best for the MRC as a whole. It is now widely known that we are exploring the possibility of incorporating our plans for NIMR into a much larger development, with several other partners, on another site [at Somers Town in central London]. I really hope that this will demonstrate to the staff of the institute that the MRC has recognized their concerns and that the new plans will provide an exciting conclusion to what has been a very difficult process.

What's your farewell message to British researchers?

The major message would be one of reassurance. The rumors and worries at least show that the community values the MRC and is very concerned about its future. I think they can be confident that its values will be preserved through this period of change and that it will emerge strengthened.

Michael Hopkin, London

Timeline of events...*a brief history of the important news stories this month*

Aug 19
President Bush's $15-billion AIDS program will fund programs that provide men in Africa with circumcisions, which are thought to reduce the risk of HIV transmission by 60%, officials announce.

Aug 23
Gastric bypass surgery, a procedure in which a portion of the stomach is stapled shut, extends the life of obese individuals by up to 40% and prevents death from diabetes, heart disease and cancer (*N. Engl. J. Med.* **357**, 753–761).

Aug 24
Out-of-body experiences can be simulated with virtual reality goggles that allow volunteers to see their own backs, suggesting that the phenomenon is the result of a confused brain (*Science* **317**, 1096–1099).

Sept 5
After months of debate, the UK decides to allow scientists to create human-animal hybrids, a practice that 61% of the country's citizens say they support (*Nat. Med.* **13**, 890–891).

Sept 2
A new drug that blocks the neurotransmitter glutamate is shown to improve the symptoms of schizophrenia in a phase 2 trial, making it the first schizophrenia drug to target a chemical other than dopamine (*Nat. Med.*, doi:10.1038/nm1632).

Aug 30
Arsenic, which seeps into wells and contaminates rice fields, is poisoning 140 million people worldwide, scientists warn at the annual Royal Geographical Society meeting in London.

Sept 5
A US advisory panel unanimously recommends speedy approval of Merck's Isentress, the first drug in a new class of AIDS drugs known as integrase inhibitors, which block the fusion of the virus's genetic material with the host cell's DNA.

Sept 6
Black women are more likely than white women to have breast tumors that do not respond to hormone therapy, suggesting that disparities in cancer survival may have a biological basis, researchers say.

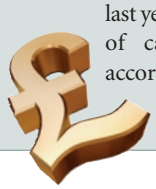
Sept 6
Introducing a mutation linked to autism spectrum disorders into mice makes them socially inept and adept at navigating mazes without inducing problems associated with previous animal models of autism (*Science*, doi:10.1126/science.1146221).

Sept 12
Mobile phones do not harm health in the short term, according to a report based on six years of research in the UK, but their effect on children and long-term users is less certain.

Sept 12
Two new studies find that the diabetes drug Avandia and a related drug, Actos, raise the risk of heart failure, a progressive weakening of the heart, but only Avandia increases the risk of heart attack and death (*JAMA* **298**, 1189–1195 and 1180–1188).

Sept 11
Elevated levels of testosterone in the womb are associated with autistic tendencies in children, but it's unclear whether the high levels are the cause or the result of the disorder, researchers announce at a science festival in the UK.

Sept 13
A group of stem-like cells found in pancreatic tumors appears to help the cancer spread and resist chemotherapy, and similar cells might be found in other types of tumors, researchers say (*Cell Stem Cell* **1**, 313–323).



Sept 14
The London-based charity Cancer Research UK doled out nearly $640 million to studies of cancer treatment, prevention and diagnosis last year, making it the largest funder of cancer research in Europe, according to its annual report.

Sept 15
Four scientists, including Anthony Fauci, director of the US National Institute of Allergy and Infectious Diseases, win Lasker awards, widely considered to be the 'American Nobel', for medical research and public service.

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Aug 27

Stem cells formed from reprogrammed mouse skin cells can easily be spotted under a microscope because they're small, round and clumped together, making genetic markers unnecessary, researchers report (*Nat. Biotechnol.*, doi:10.1038/nbt1335).

Aug 28

China proposes a new law to ensure that researchers who fail aren't denied funding, a measure intended to encourage risk-taking and reduce scientific fraud.

Aug 29

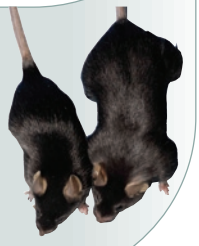
Type 2 diabetes may develop as a result of cells in the hypothalamus becoming less sensitive to glucose, and not simply as a result of insulin resistance, say US researchers (*Nature*, doi:10.1038/nature06098).

Aug 30

By combining a seawater enzyme with a chemical found in algae, researchers produce brevetoxin, a neurotoxin found in Florida red tides, the antidote to which holds promise as a treatment for cystic fibrosis (*Science* **317**, 1189–1192).

Aug 29

Mighty mice, developed ten years ago, become four times mightier when they are engineered to overproduce a protein called follistatin that boosts muscle growth, researchers say (*PLoS ONE* **2**, e789).



Sept 9

Humans who eat high-carbohydrate diets have evolved to carry more copies of a gene that helps breaks down starch, indicating that diet can shape genetic makeup, scientists report (*Nat. Genet.*, doi:10.1038/ng2123).

Sept 10

Drug-related deaths and other adverse events reported to the US Food and Drug Administration (FDA) have tripled since 1998, according to researchers, who say the rise reflects poor monitoring of drug safety (*Arch. Intern. Med.* **167**, 1752–1759).

Sept 10

Scientists grow a durable heart valve leaflet by seeding sheep cells on a mold, a first step toward developing living, growing heart valves for children (*Circulation* **116**, I-55–I-63).

Sept 11

Women who take a contraceptive pill for less than eight years lower their risk of any kind of cancer by 12%, but those who take it for longer raise their risk by 22%, researchers report (*BMJ*, doi:10.1136/bmj.39289.649410.55).

Sept 10

People who take vitamin D supplements have a 7% lower risk of death, on average, than those who don't, say researchers who analyzed 18 studies totaling more than 57,000 individuals (*Arch. Intern. Med.* **167**, 1730–1737).

Sept 10

US supplies of the AIDS drug Viracept are found to contain traces of the same potential carcinogen that contaminated Europe's supply in June, prompting the FDA to recommend that pregnant women switch to an alternative drug.

Sept 18

A mathematical model predicts that giving sub-Saharan Africans a daily dose of antiviral medication could potentially prevent 3.2 million cases of HIV infection over the next ten years (*PLoS ONE* **2**, e875).

Sept 20

Biologists debut the genetic sequence of the roundworm parasite that causes elephantiasis, a tool that may help develop new vaccines and drugs to treat the disease (*Science*, doi:10.1126/science.1145406).

Sept 20

Restricting caloric intake appears to prolong life by ramping up expression of two genes that keep mitochondria healthy, providing potential drug targets for age-related diseases, researchers say (*Cell* **130**, 1095–1107).

Funding is tight. Grants are rejected. Research equipment is too expensive. And these are complaints heard in well-heeled laboratories in the US and UK. In the following pages, we present inspiring examples of scientists who, using materials as simple as litmus paper, bamboo and blenders, prove that science on a shoestring is possible—and sometimes even better than the alternative.

Microscopes made from bamboo bring biology into focus

In a remote village in eastern India, dozens of underprivileged children are for the first time marveling at the elaborate details of flower petals with the help of a microscope—made out of bamboo.

Fitted with a ×20 lens, the light, compact and ecofriendly microscope is proving a boon for dozens of cash-strapped schools, granting students firsthand access to an otherwise unaffordable scientific tool.

This nifty device is a product of the creative minds at Jodo Gyan, a small nonprofit in New Delhi. "Indian children are not getting to experience all the joy and wonder of science because there is too much emphasis on the memorization and repetition of concepts," says Usha Menon, a government researcher who founded Jodo Gyan in 1999. "Hundreds of thousands of children are learning without understanding anything."

Priced at 150 rupees (roughly $4), the microscope is just one of the educational tools created by Jodo Gyan, literally translated as 'linking knowledge'. Other tools include mathematical card and board games and sticky geometric shapes in a variety of colors. The 30-member group has also led more than 700 teacher-training workshops and runs an alternative primary school that enrolls 54 underprivileged students.

Clear vision: Members of the Delhi-based nonprofit Jodo Gyan have made about 2,500 microscopes from bamboo.

But the microscope remains the star attraction. Jodo Gyan has supplied the instrument to several organizations such as Chennai's Goodbooks Teacher's Center and New Delhi's Pragya, a nonprofit that provides services to neglected, high-altitude areas. These organizations then distribute the microscopes to schools in their localities. Jodo Gyan has also secured two big orders in the last few years from the UN Children's Fund for use in alternative learning centers in India.

But with no external funding, Jodo Gyan is run on a shoestring budget, particularly because the group sells its learning aids for not much more than it costs to produce them, says Menon. The group's base of operations is a ramshackle building in Delhi's impoverished Shakurpur area that also doubles as Menon's home.

To meet the demand for its popular microscope, Jodo Gyan has fashioned a makeshift microscope factory right on the building's roof. Sitting up there amidst bamboo shards, members have so far chopped and carved about 2,500 microscopes for use in schools, educational nonprofits and, in at least one case, research.

Debal Deb, an ecologist who has set up a rural seed exchange to conserve dozens of endangered folk rice species in West Bengal, routinely uses Jodo Gyan's microscopes to study the surfaces of rice grains. More important, Deb's microscope has caught the attention of dozens of curious children from nearby villages, who stop by after school to peer through its lens.

"The microscope has opened up a whole new world for these children," says Deb. "They could never have imagined that an ant could have tiny antennae or that dragonfly wings could have such beautiful and intricate patterns."

Paroma Basu, New Delhi

pH paper trumps expensive kits in measuring acidity

Scientists in Uganda have devised a tool to test for vaginal infections that is so simple, even a child could—and did—make one.

In 2000, scientists at the Rakai Health Sciences Program in Kalisizo began studying the natural history of bacterial vaginosis, a common condition that lowers the acidity of the vagina. Using just a strip of pH paper, a bit of tape and a pediatric tongue depressor, they devised a 'swab' to measure vaginal pH.

Although the test itself was simple, coming up with a working design wasn't easy. "At that time we had never measured pH," says Mary Sullivan, a former Rakai lab manager who now coordinates hepatitis research at Johns Hopkins University.

For a previous study of sexually transmitted diseases, the researchers had shown women in nearby villages how to use cotton swabs to collect their vaginal secretions. Although fluid from a cotton swab can be smeared onto pH paper, the swabs are not ideal for measuring pH because they may not release enough fluid for an accurate reading.

Swabs can also easily become contaminated. "If the swab stayed in the air too long, if it was put on a surface or dropped, that would affect the reading." Sullivan says.

The researchers instead attached a four-inch strip of pH paper to a pediatric tongue depressor so that the measuring pad, which changes colors in response to the acidity of the environment, is at the tip. On either side is a color-coded pH key. "[The method] turned out to be very, very feasible," says Noah Kiwanuka, an investigator at the Rakai Health Sciences Program who oversaw the field work.

Once the researchers had proved that the swab worked, they set up an assembly line in Sullivan's dining room and convinced her three daughters, then between the ages of six and ten, to help. "One of them would open the tongue depressor package and pass it to the next, who would put the strip over the top, and then the third one would put the tape around and put it back in the bag," Sullivan says.

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Teachers' group brings genomics revolution to minority colleges

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When the human genome sequence was released in 1999, it meant two things to Edison Fowlks, a biology professor at Hampton University in Virginia.

First, genomics technologies were about to revolutionize science. And second, students and faculty of so-called minority-serving institutions such as Hampton, a historically black college, needed to be part of the revolution.

But where were such institutions going to come up with the funds to train faculty in the new technologies—much less buy microarrays and the scanners needed to read them?

In 2004, Fowlks found an answer when he met fellow biologist A. Malcolm Campbell, who since 2000 had been organizing a program called Genome Consortium for Active Teaching (GCAT) for faculty at small undergraduate institutions. Campbell is himself a researcher at Davidson College in North Carolina, a liberal arts college with 1,700 students.

Campbell had convinced genomics pioneer Pat Brown of Stanford University to donate microarrays, which Campbell then mailed to dozens of other professors. These professors taught students how to do experiments with the chips and then mailed them back to him. Campbell then read data from the chips using a single scanner and sent it back to the professors, who analyzed it with free software written by one of Campbell's colleagues. The only charges for chip users were shipping fees and the cost of the reagents for their experiments—no more than $500.

Fowlks saw the power of the model immediately. "GCAT essentially democratizes genomics," he says. "It allows a consortium of small colleges and universities to do informatics and genomics without all the powerful equipment that major universities have."

Fowlks joined forces with Campbell to expand GCAT's reach. The pair wrote a grant, awarded by the US National Science Foundation, to support a GCAT workshop at Morehouse College in Atlanta in 2005. The agency has committed to funding yearly workshops through 2009; the most recent of these, held this July, trained 40 teachers.

Genome Consortium for Active Teaching

Bring on the revolution: Using donated microarrays and a single scanner, minority faculty and students are jumping into genomics research.

The workshops are open to anyone who teaches undergraduates, with an emphasis on faculty teaching minority students. Since 2003, the Howard Hughes Medical Institute has spent $100,000 each year to buy microchips for the program. This year, GCAT distributed 1,200 chips to 72 teachers at institutions across the nation, from Alaska to Hawaii and Puerto Rico.

This fulfills not only Fowlks's and Campbell's goals, but also those set out by numerous reports on American competitiveness, such as a 2005 National Academies manifesto that calls for the nation to train more minority scientists and engineers.

"The National Academies and so many other groups have said we need to increase diversity in science, and I don't know how that's supposed to happen if we don't reach out to schools that serve large numbers of minorities," Campbell says.

GCAT is already showing results. Scientists such as Consuelo Alvarez at Longwood University in Farmville, Virginia, are publishing genomics research, and students such as Hampton University senior Sabriya Rosemond are getting swept into the genomics revolution.

Rosemond, one of Fowlks's former students, has worked in biology labs for the past two summers and is determined to go into science after she graduates next year. "I want to make science a little browner, like Dr. Campbell and Dr. Fowlks are doing," she says. For the GCAT leaders, that's an even more satisfying benchmark than the growing list of grants and papers that they are helping to produce every year.

Erika Check, San Francisco

Rakai Health Sciences Program

Simple solution: Women and children made swabs needed to test vaginal pH for a clinical study in Uganda.

The kids received their wages in gourmet gummy bears and M&Ms. On a good night, the team would make 200 swabs.

The researchers used the swabs to follow weekly changes in vaginal pH in 311 women over two years. "It's a poor woman's way of doing it," says John Thorp, a gynecologist at the University of North Carolina, who was not involved in the project. "I think that taking the [vaginal] speculum out of it greatly diminishes the cost."

Sullivan and her colleagues used to joke about patenting the swab. But it's too late. In July, New York–based company Vagisil launched its own over-the-counter version, a spatula-shaped 'wand' that measures pH.

The study ended in 2003, and the handmade pH swabs are no longer being used. But the researchers plan to revive their approach if necessary: a tube of pH strips and a box of tongue depressors are still cheaper than the $15 tab for a Vagisil kit.

Cassandra Willyard, New York

Turning one lab's trash into another's treasure

Miguel Omar Velardez was bracing himself for his return to Argentina after years at richly funded Harvard University. He had a position lined up at the University of Buenos Aires, and the Argentinian government was paying for his move, but start-up funds were not a part of the package. "They say, 'we love you, we love your research, this is your place: 36 square meters of empty lab and no grants so far.'"

Seeding Labs

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Helping hands: Volunteers from Seeding Labs test and pack equipment for labs in resource-poor countries.

When Velardez heard from a friend that he could get used lab supplies for a pittance, he jumped at the chance. Seeding Labs, a nonprofit launched in 2002 by a group of Harvard graduate students, found him a titer-plate shaker, a stirring hot plate and a UV illuminator, all discarded by Doug Melton's lab at the university.

Two graduate students came by and picked up the equipment, and three others tested the pieces to see if they worked. By the time you read this article, the equipment will be in Argentina, helping Velardez work out the role of the protein neuregulin in puberty.

"I want to demonstrate that with just a little help, you can do very good science here in a developing country," says Velardez.

The help Velardez received is a natural extension of what many researchers in resource-poor countries already do—accept *ad hoc* donations from colleagues in rich countries. Since the nonprofit's launch, Seeding Labs volunteers have donated old but serviceable lab equipment worth about $300,000 to 11 labs, spending only $8,000, mostly on shipping.

"We had all worked in labs in developing countries, we had seen firsthand what it means to do science in these countries," says cofounder Nina Dudnik, a molecular biology student at Harvard's medical school who has spent time working in the Ivory Coast. "We walked the halls at night and saw the trash that people were putting out, and half of it was usable lab equipment. It seemed obvious."

The 70 volunteers collect water baths, vortexes, PCR machines, pipette tips and the like, test the machinery and make simple repairs. Funding comes from the New York–based 'angel investor' Echoing Green, Harvard, and the Sustainable Sciences Institute in California (see page 1132). Seeding Labs is seeking more funds to expand and establish a scientific advisory board to help vet and prioritize requests.

The group's recipients were initially labs in South America that were working with the Sustainable Sciences Institute and have expanded to include Paul Farmer's Haitian charity Partners in Health and Congo Protestant University in Kinshasa, which opened a medical school last year.

"There are about 20 organizations in the country that donate surplus hospital equipment," says Melvin J. Loewen, a former president of the university who now coordinates support for it from his home in Indiana. "Our frustration was that we couldn't find anything that was dealing with the chemistry, biology and physics of pre-med. I think what these grad students are doing in the Boston area is excellent."

Emma Marris, Columbia, Missouri

Sometimes the simplest solutions are the best. Scientists have transformed a blender into a centrifuge (**a**), recycled gloves (**b**) used a soda bottle as a make-do ice bucket (**c**), devised a simpler flow cytometer (**d**) and invented a tip washer for rinsing out pipet tips (**e**).

a

Sustainable Sciences Institute

c

Sustainable Sciences Institute

b

Sustainable Sciences Institute

Simpler tests for immune cells could transform AIDS care in Africa

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Over the past decade, access to costly AIDS drugs in the developing world has expanded dramatically. But deciding who could most benefit from those drugs hasn't become much easier.

Simpler, cheaper versions of the test that can indicate when an HIV-positive individual needs treatment could bring quality HIV care to even the remotest parts of Africa. Academic researchers, industry and nonprofits are all developing new tests, at least seven of which are already in use, with six more in various stages of development.

In richer countries, doctors determine who is in need of antiretroviral drugs by assessing the infected individual's CD4-cell count, which reflects the health of their immune system. Those individuals with fewer than 200 CD4 cells, the immune cells that HIV destroys, need drug therapy even if they appear healthy.

CD4 cells are usually tallied by an expensive and complicated machine called a flow cytometer, a standard tool in biology labs. The bulky machines require a steady supply of electricity and highly trained technicians. "For these rural parts of sub-Saharan Africa, there's no way a flow cytometer is going to work," says Steven Reid, project manager of the CD4 Initiative, a public-private effort that aims to develop cheaper tests.

At a minimum cost of about $50,000, the standard machine is also well beyond the reach of most developing countries. Healthcare workers instead often rely on their instincts or wait until a person is visibly sick before providing treatment.

"That completely compromises their care," Reid says. "A simple test to say, 'You need treatment [or] you don't' would be a huge step forward."

Funded by an $8.6 million grant from the Bill & Melinda Gates Foundation and overseen by Imperial College London, the CD4 Initiative expects to debut a simpler version of the test by 2011 that would be as easy to use as a home pregnancy test. The test would take in a drop of blood and generate a symbol—perhaps a plus or minus sign—to indicate whether an individual needs to start drug therapy.

Scientists in South Africa have also tried to simplify CD4 testing by eliminating some of the steps in the conventional tests. "[The steps] add extra cost and are really not necessary," says Debbie Glencross, a hematologist at the University of the Witwatersrand in Johannesburg.

Her shortcut slashed the cost of a test from about $80 to $7, prompting all 52 government labs in South Africa to implement it. The new test may even be more accurate, because fewer steps leave less room for error, Glencross adds. "Even if we had all the pots of money in the world I wouldn't swap back."

Debbie Glencross; University of the Witwatersrand

Sheer volumes: Sorting through samples to identify those in need of AIDS drugs is complicated and time-consuming.

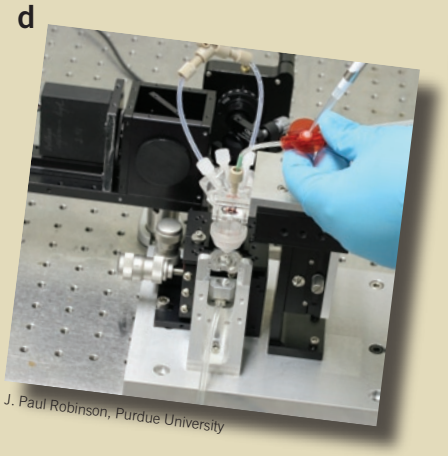
Glencross's method still relies on a basic flow cytometer and a lab in which to operate it. Another model, developed by J. Paul Robinson, director of Purdue University's Cytometry Laboratories, could be used in villages that lack labs or even electricity.

Robinson's prototype is a rechargeable mini-cytometer small enough to fit in a suitcase and simple enough to be used with little training. But finding funding for its development has been difficult. Since he received an initial $250,000 donation from Cleveland-based company Parker Hannifin, "not a single penny has come from anybody," Robinson says.

With 4.8 million people in need of antiretrovirals in sub-Saharan Africa alone, however, the potential market for a new test is enormous—and has prompted several companies to join the fray. In 2004, California-based Guava Technologies released a portable flow cytometer. That same year, BD Biosciences, which garnered $500 million in cytometry-related sales last year, agreed to slash the cost of its two most basic machines by about a third in Africa and the Caribbean.

Still, these machines are out of reach for most: Guava's version sells for $35,000 and BD's cheapest machine for $25,000. Robinson, who operates a nonprofit called Cytometry for Life, expects to see his model cost about $5,000. "It's truly a low-cost solution," Robinson says. "That gives me confidence that at some point someone will see the light and fund us."

Cassandra Willyard, New York



INGENIOUS INVENTIONS

Straight talk from... **Eva Harris**

Since the late 1980s, the San Francisco-based Sustainable Sciences Institute has made it its mission to train scientists in resource-poor countries and help them cobble together low-cost devices—to "give people the tools they need and let them run with them," as its ebullient leader Eva Harris says. Among the institute's most famous inventions, for example, are a centrifuge made from a blender and a no-frills PCR method that uses homemade thermal cycling equipment and ceramic dust instead of silica for purifying the DNA. A 1997 MacArthur fellowship allowed Harris to expand the institute from an informal setup to a more official organization. Since then, with an annual budget of about $1 million that is coaxed from foundations and from individual donors, the institute has held more than 30 workshops, training mainly Latin American scientists in topics ranging from diagnostics to epidemiology to grant writing. The institute also gives out mini-grants to the most promising projects. Here Harris talks about the philosophy behind the institute's unique approach, its successes, its many ongoing projects and the eternal struggle for funding.

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What distinguishes the institute from other efforts to boost research capacity worldwide?

A lot of successful efforts involve researchers with a US grant finding partners in developing countries. But those efforts are often driven by the first-world scientists and agendas. We listen first to the priorities of the scientists who are asking for our assistance. And that often takes longer than if the 'North' just drives the agenda. We also always have instructors from one country who we have already trained as our instructors for the next workshop in another country in the region.

One scientist who took our workshops, Nataniel Mamani at the Universidad Mayor de San Andrés in La Paz, Bolivia, created a course on how to make your own lab equipment. We have been doing a bit less of that kind of tinkering lately, but what I think is really important is the philosophical concept that all of these techniques are doable if you understand the fundamental principles. We have broadened our approach to helping people set up a lab with what they have and what we can help them get.

How do you choose where to work?

We would probably be bigger if we didn't focus on countries or parts of countries with little infrastructure. But we have been very dogged about staying with that mission. It is very much about responding to needs. Other people work on creating new technologies and methods; we are concerned with getting what exists out there.

If you do that, you sometimes get a wonderful kind of leapfrogging. In Nicaragua, we are following 3,800 kids over six years in a dengue study. In the beginning, we thought maybe we would put photographs on the identification cards. Within eight months, our Nicaraguan team suggested barcodes on the ID cards, and then, within two months, they had transformed the whole study to work using barcodes, fingerprint scanning, global positioning systems and hand-held computers. Their approach has expanded to other parts of the healthcare system such as vaccination efficiency and prenatal care. It was completely not what I had been thinking. I am surprised every time.

What kind of projects do you tend to fund?

It has morphed over the years, but we have always tried to support research with a public health focus. Much of it is basic lab setup and training. We work with diagnostics and reference and research labs within the context of the priority diseases of the country.

For example, in Paraguay there was a huge dengue epidemic in 1999 and 2000. Local scientists came to us and we set up a partnership with the university and the ministry of health. We brought them equipment and supplies. I trained one of their people here, and then we went down and did several workshops. They were able to do active surveillance and pick up outbreaks from areas around the bus station from Brazil before they spread. But then came political changes which removed the people we trained, and there was a bad dengue outbreak there more recently.

What is the greatest hurdle you face?

"We are empowering our partners in developing countries."

Our focus on people is our Achilles heel. Our institute is in the nonprofit sector, and our work should be allowed to be about people. But most foundations are not really interested in training people. They want gadgets, they want research, they want projects. People love our model, and yet it is hard to fund. Metrics are rather difficult in training. It is not as easy as if we distributed 40,000 of this or that. And it is actually more profound than that. We are empowering our partners in developing countries and instilling them with confidence.

What do you feel is your biggest failure?

People tell me I am a dynamic speaker, but I am not a business type. I am probably not selling the institute the right way. I've talked to people from the Bill & Melinda Gates Foundation, and several times they were sending the check and then they reorganized. It makes me uncomfortable to sell; it rubs me the wrong way. I don't like to sully this beautiful stuff with money.

What drew you to this kind of work?

I grew up between New York and Paris in a progressive household. I am an only child and I was very influenced by my parents' friends, many of them European socialists. And I always was interested in biology. So I wanted to share my educational privilege with people less fortunate. I wanted to go to the developing world, but I didn't want to go as a tourist. At that time, Nicaragua was in the middle of the revolution, and they were accepting technical specialists as volunteers. This was in the Reagan '80s, and I was very unhappy with foreign policy and the Contra war. I was unhappy with what was being done overtly and covertly in our name and felt it should be possible to work internationally in a positive way.

In Nicaragua, there was running water maybe twice a week and roosters running everywhere, and 100-degree heat every day in the middle of an economic blockade. But together with my Nicaraguan colleagues, I created a series of workshops by listening to what they needed. They had a problem with leishmaniasis, and they wanted to learn molecular biology. Through the workshops, I was able to teach them PCR right after it was invented, and it was the first time anyone in the country had seen DNA. We were able to diagnose leishmaniasis rapidly, determine the species of the parasite and develop diagnostic tools that were implemented immediately at the national level. I realized that the key to this kind of work is to understand the principles and partner with people in an equitable, respectful and long-term manner. We are still there.

Emma Marris, Columbia, Missouri