CHASING the MONEY

As constraints take hold in biomedicine, scientists are forced to adapt

MONEY. IT IS WHAT FUELS RESEARCH, AND these days, it's almost all biomedical scientists in the United States can talk about.

They've been buffeted by funding swings at the National Institutes of Health (NIH), their field's primary benefactor. And now they're anxious about the future, as Congress tries to rein in debt by slowing government spending.

One result: Morale is as low and uncertainty as high as she's ever seen it, says molecular biologist Shirley Tilghman, president emerita of Princeton University. "The image that comes into my head is a seesaw," she says. "The highs are higher and the lows are lower."

Not everyone is teetering. Some researchers and universities are raking in record-setting sums, in part by aggressively diversifying their funding sources (*Science*, 21 June 2013, p. 1394). But the triumphs only underscore a dominant theme: The U.S. funding landscape is shifting. And with change comes adaptation.

For this special package, *Science* explored how biomedical research at U.S. universities—a $32 billion enterprise that involves hundreds of thousands of people—is reshaping itself. We found a complex mosaic, captured in the profiles that follow. To put them in context, it helps to examine what the hard data can—and can't—tell us about what's really happening on the ground.

What we know

Over the past 20 years, federal investment in R&D as a share of the gross domestic product has fluctuated above and below 1%, and now stands a bit under it. Biology has long been a favored child of funders, its allure growing with time. Today, roughly two-thirds of federal R&D money at universities goes to the life sciences, about 10% more than in the early 1970s. Industry spending also increased in the 1980s and 1990s, and now provides about 7% of the R&D dollars that flow to universities.

At the same time, NIH's budget has sustained wild swings that many economists say make for an inefficient research enterprise. Between 1998 and 2003, the agency's budget doubled, from less than $14 billion to more than $27 billion. For the next 5 years it stayed largely flat. Then came an infusion of $10.4 billion in 2009, part of the federal stimulus plan to fight the recession—followed by a sizable bump downward in 2013, a 5% across-the-board cut from the sequester.

Universities responded predictably to the budget doubling: They expanded, adding new buildings and filling them with staff members and trainees, who needed money of their own to thrive. In 2002, a commentary in *Science* suggested that biomedical researchers had become dependent on annual budget increases of at least 6% (24 May, p. 1401). But

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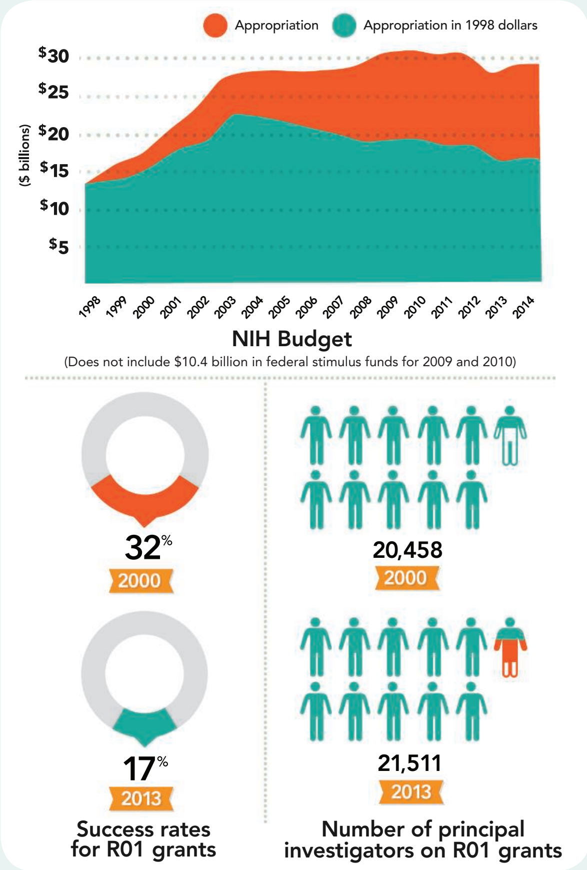
that didn't happen. "[T]he fundamental problems are structural in nature," concluded Michael Teitelbaum of the Alfred P. Sloan Foundation in New York City 6 years later (*Science*, 1 August 2008, p. 644). "[B]iomedical research funding is both erratic and subject to positive-feedback loops that together drive the system ineluctably toward damaging instability."

That instability is now on vivid display. On the one hand, the future looks a tad brighter: NIH's 2014 budget increased 3.5%, to $30 billion. But that will likely not be enough to sustain the community as it hopes. NIH's grant approval rate dropped below 17% last year, compared with about 30% in the late 1990s, and the average size of standard research grants fell for the first time in recent memory.



What it all means

Some say the endless complaints about money are a bit much: After all, NIH is still the biggest funder of biomedical research in the world. Universities and other institutions kick in another $7 billion from various sources to support their biology researchers.

But inflation is taking a bite. In 2013, the NIH budget of $29.15 billion was, when adjusted for inflation, almost $5 billion less than the $27.17 billion available in 2003. And some economists argue the losses are even greater, because the cost of gene sequencers, supercomputers, and even mice usually rise faster than the general rate of inflation.

The funding swings have also exposed a mismatch between how the government supports biomedical research—one fiscal year at a time—and how science is practiced—incrementally, with progress measured in years or even decades. Because NIH now approves less than one in five grant applications, scientists say they are spending more of their time submitting proposals—leaving less for the research needed to win grants in the first place.

What we don't know

It's "appalling how little is known" about how the community is adjusting to these pressures, says Julia Lane, an economist at the American Institutes for Research in Washington, D.C. Are young investigators suffering more than established ones? Are smaller labs contracting more than larger ones? Which fields of research are most affected? "You have these major adjustments, and it's shocking that there is no method of understanding what the impacts are," Lane adds. "The science agencies are charged with building, identifying, and funding the best science. They don't have as their mandate to answer these questions." Dark rumors abound, fueling the sense of unease.

Online
sciencemag.org
Podcast interview with author Jennifer Couzin-Frankel (http://scim.ag/pod_6179).

For NIH, the knowledge gap can hamper its decision-making. The agency makes it easier for new investigators to get funding, for example, but it doesn't know how they fare 5 years out, when their first big grant is up for renewal. "We want to make sure we're not setting them up for failure," says Sally Rockey, NIH's deputy director for extramural research. The agency plans to start tracking these people, to gauge whether they're headed for dire straits.

Also hotly debated is whether NIH should scale back support for the 1600 or so "millionaires," the principal investigators who boast more than $1.5 million a year in grant money. NIH gives their proposals extra review, but in most cases offers additional support with peer reviewers' blessings, "because," Rockey says, "we're a meritocracy." Jeremy Berg, a former NIH institute director who's now at the University of Pittsburgh, recently found that more than 80% of those who already receive about $650,000 a year in direct support from the Howard Hughes Medical Institute also get money from NIH—an average of two grants each, or roughly another $400,000 a year. (This funding does not include so-called indirect costs, which allows the institution to cover overhead.) "Should we be supporting a smaller number of investigators but at a very rich rate," Tilghman wonders, "or should we be letting 100 flowers bloom?"

Economists are trying to answer some of these questions (see Policy Forum, p. 41). At the University of North Carolina, Chapel Hill, Maryann Feldman is poring over records from nine universities to understand how the support that labs receive influences publications, patents, and researcher characteristics. Feldman is also studying "venture philanthropy," which applies businesslike goals to charity work, to see how academics are relying on it and whether it redirects their research. At Ohio State University, Columbus, economist Bruce Weinberg is exploring how the structure of a lab and its funding shape the training of graduate students and postdocs and their professional future. "Hopefully the data will be built" to show how the community is adjusting, Weinberg says. "But it's not there yet."

Some suggest a rethinking of the entire enterprise. "I think for a long time people in biomedical science bought into what you hear in industry, which is, 'If you don't grow, you die,'" Tilghman says. "And it's not true, it's absolutely not true." Maybe, she suggests, scientists and their institutions should question whether they are well served by ever-expanding labs, flanked by construction cranes building still more facilities.

The end result for some senior scientists right now is caution: Play it safe, tighten your belt. That could have a trickle-down effect to the mouths they help feed. "I cannot take a grad student and make a 5- to 6-year commitment," says Arturo Casadevall, a microbiologist and immunologist at Albert Einstein College of Medicine in the Bronx, New York. "I don't know where we're going to be in 5 or 6 years."

–JENNIFER COUZIN-FRANKEL

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Chasing the Money

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