Scientists are happy about another huge proposed boost for NIH, but they say there's more to science than biomedical research

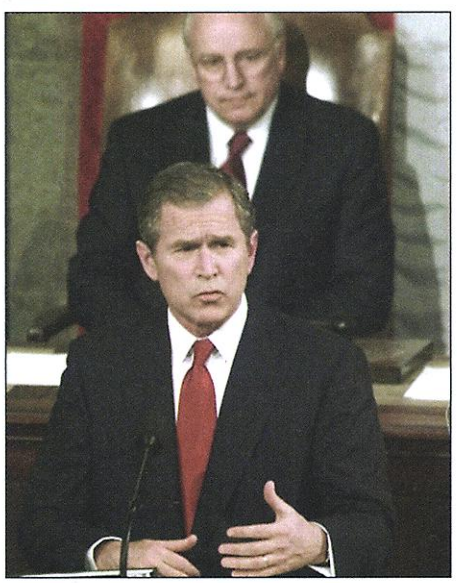
Science Lobbyists Aim for Better Balanced Budget

Don't get mad, get moving. That seems to be the scientific community's reaction to President George W. Bush's lopsided budget request to Congress, which showers biomedical science with cash and largely snubs the physical sciences. Despite the disparity, few science lobbyists are openly complaining. Instead, they are stepping up efforts to convince Congress to rewrite the budgets of the National Science Foundation (NSF) and other losers in the opening round of the 2002 budget contest. "There is no point in antagonizing the new Administration," says one science society operative in a comment echoed by many of her peers. "We're looking ahead."

The Bush plan, released on 28 February, is just a skeletal outline; full details won't come until early April. But the 175-page document, "A Blueprint for New Beginnings," makes clear the new Administration's R&D priorities for the 2002 fiscal year that begins on 1 October. Leading the list is a 13.8% increase, to $23.1 billion, for the National Institutes of Health (NIH). That boost, which Bush announced last week (*Science*, 2 March, p. 1677), would keep the agency roughly on track to double its budget by 2003. The plan also favors Pentagon research programs, proposing a 6% hike to about $45 billion, and corporate research, promising to make permanent a tax credit for industrial R&D spending that would otherwise expire in 2005.

But the list of winners among government science agencies is short. High-profile interagency initiatives on nanotechnology and information technology have disappeared, leaving those disciplines to compete with every other field for scarce resources. NSF and NASA are slated for increases of 2% or less—below the expected rate of inflation. The $19.7 billion Department of Energy (DOE) faces an overall 3% cut, with an unknown portion coming out of its $3.4 billion Office of Science. The U.S. Geological Survey (USGS) could lose 11% or more of its $883 million budget, while the Department of Commerce's $145 million Advanced Technology Program, which funds precompetitive industrial research, would be abolished. The plan also calls for canceling several space science missions and a study of whether NSF's ground-based astronomy program should be transferred to NASA (see sidebar).

Health and Human Services Secretary Tommy Thompson was the most visible Administration official on budget day, conveying the good news in person after visiting NIH's clinical and research facilities. But most other high-level science officials had little to say. Citing increases for graduate student stipends and mathematics research that total less than $30 million, NSF Director Rita Colwell issued a brief statement saying that "the president's priorities clearly mirror our own in these areas." She pointedly ignored any mention of the agency's meager increase of 1.3%.



Favored child? NIH would get most of the increase for science in Bush's 2002 budget.

The numbers also got a lackluster reaction from researchers and lawmakers. Biomedical groups plan to push for an even larger raise for NIH, to $23.7 billion. And even some Republican lawmakers are worried that skimping on basic research at NSF will hamper the quest for economically valuable technologies in many fields. "NSF's number is a concern," says Senator Wayne Allard (R–CO), a member of the Senate's Republican High-Tech Task Force.

Seizing on such doubts, science lobbyists are targeting a congressional budget resolution, due out next month, that will set overall levels for broad budget categories. The heads of dozens of major research universities, for instance, wrote on 1 March to Senate Budget Committee chief Pete Domenici (R–NM), requesting that he "pay special attention to the NSF in this year's resolution." Domenici has already said that he wants to boost Bush's request for $661 billion in discretionary spending—the one-third of the federal budget not dedicated to social welfare programs.

Other prominent Republicans have hinted that the Administration's proposed $1.6 trillion tax cut over 10 years may be scaled back to free up more cash. White House officials, meanwhile, have threatened to veto any final appropriations bills that raise spending beyond the requested 4% increase. That sets the stage for a confrontation over R&D funding likely to continue into the fall.

The president's budget contains these highlights for selected science agencies:

• **NSF:** A record $530 million increase last year lifted its budget to $4.4 billion, the first step in what agency officials hoped would become a 5-year doubling path. But this year's increase would be barely one-tenth that size, a meager $56 million.

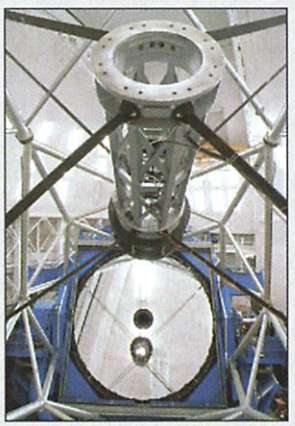
Within an essentially flat budget, a $200 million state-based math and science education program receives top billing. And although details of the program, initially based at the Department of Education, remain sketchy, NSF officials already know that they must squeeze $110 million from existing education programs to pay for it. Highly touted Clinton initiatives in information technology and nanotechnology—which together received a $190 million boost last year—lose their place of honor in the new budget, leaving NSF officials scrambling to continue research in those areas without an infusion of new money.

The budget outline also questions one of NSF's top priorities: increasing the size and duration of grants. "There is little documentation that this is having a positive impact on research output," the president's budget de-

CREDIT: RON EDMONDS/AP

Budget Could Send Space Science Off in New Directions at NASA

The budget outline the White House unveiled on 28 February caps a week of startling news for NASA. On orders from the White House, NASA managers last week told Congress they intend to cancel plans for a Pluto flyby and a mission to study the solar wind. The agency is also following orders to make major cuts to the international space station after acknowledging huge cost overruns in the orbiting lab. Meanwhile, the president has called for a blue-ribbon panel of scientists to decide whether the space agency should swallow up the ground-based astronomy program run by the National Science Foundation (NSF).



Merger? Budget weighs shifting NSF astronomy facilities *(above)* to NASA's space science program.

Congress may not go along with all the directives in the president's budget, which would boost NASA's $14.3 billion budget by a modest 2%. But observers see the flurry of activity as a sign that the new Administration intends to grapple with difficult issues sidestepped by President Bill Clinton's team. "They seem interested in solving problems that have been left in the closet," says Bill Smith, a former Democratic House staffer who runs the Washington, D.C.–based Association of Universities for Research in Astronomy.

For example, the president's 2002 budget would kill off the Pluto and $350 million Solar Probe missions in favor of Mars exploration and high-energy astrophysics missions, setting clear priorities within a limited budget. But Congress may have other ideas: The current competition to build a cheaper and faster Pluto mission for a 2004 launch remains on track after a Senate spending panel told NASA space science chief Ed Weiler late last week not to pull the plug. Weiler has agreed to let bidders go ahead with their proposals, due this summer.

Support for some type of mission to Pluto also remains strong in the scientific community. "Stay tuned. Pluto isn't dead yet," says planetary scientist Michael Drake of the University of Arizona, Tucson, who chairs a NASA advisory panel on solar system exploration. "Pluto has not been targeted; it's just that it is seen as a new start, and there's not enough money." Indeed, the Bush budget contains money for new propulsion technologies that, if feasible, could allow a "future sprint" to Pluto before 2020, according to the budget plan.

Also controversial is the White House decision to create a blue-ribbon panel to examine the government's astronomy programs, which traditionally have been split between ground-based telescopes funded by NSF and space-based observatories funded by NASA. The panel, the budget plan says, should consider "the pros and cons of transferring NSF's astronomy responsibilities to NASA," which currently funds about two-thirds of the federal astronomy grant pie. The group, expected to consist of eight to 10 eminent outside scientists, is due to report its findings by 1 September.

The directive came as "a real shocker," says Weiler, adding that "NASA did not initiate this request." A recently released National Research Council report on the next decade of astronomy makes no mention of the need for such a transfer. But Smith and Administration officials say that there is dissatisfaction at the White House Office of Management and Budget over the lack of cooperation between the two agencies, institutional expertise, and concern about whether NSF's budget will have room for major facilities.

Although such a review is reasonable, says Robert Eisenstein, head of NSF's math and physical sciences directorate, "we can make a dramatically good case" for keeping the two agency efforts separate. "You need both players," he adds, pointing to NSF's track record on such recent large projects as the twin Gemini telescopes and the Laser Interferometer Gravitational-Wave Observatory. Weiler has his own concerns. Any transfer that takes place without an accompanying shift of staff and money, he warns, "would be a disaster for astronomy."

In human space flight, the Administration took NASA to task for allowing space station costs to balloon over the next 5 years by an estimated $4 billion. To pare back, agency officials say they will cancel a module devoted to crew quarters and a large rescue vehicle, shrink the crew size from seven to three, and put off decisions about future facilities. While the budget warns NASA to set aside enough money for "research equipment and associated support," fewer facilities and a smaller crew mean science may suffer in the long run.

–ANDREW LAWLER

With reporting by Jeffrey Mervis.

CREDITS: (TOP TO BOTTOM) GEMINI; ILLUSTRATION: CXC/TRW; SARAH MARTONE/AP

Counterweight. Societies hope Senator Pete Domenici will rescue physical sciences.

clares about recent efforts to do so. "There is no question that researchers will be more effective if grant sizes and duration are increased," counters computer scientist Anita Jones of the University of Virginia, Charlottesville, vice chair of the National Science Board, which oversees NSF. NSF-funded biologists, she notes by way of example, receive grants less than half the size of NIH awards. To clear up the confusion, the Administration wants NSF to enclose supporting data when submitting its 2003 budget request in the fall.

The Bush budget would also delay any new facilities. That includes the $400 million Atacama Large Millimeter Array, a joint project with the European Southern Observatory in the Chilean high desert that NSF had hoped to start next year, and two large networked facilities, for seismic monitoring and biodiversity assessment, that Congress deferred this year.

NSF's dark cloud has two silver linings. The first is a boost, from $18,000 to $20,500, in annual stipends for graduate students in a variety of discipline-based and agencywide programs. The second is an additional $20 million for mathematics research. But Colwell had also hoped to raise postdocs' stipends, and the math figure is a far cry from an NSF proposal to quadruple the division's current $122 million budget in 4 years.

• **DOE:** Early indications are that most science programs will emerge relatively unscathed by the proposed 3% cut to DOE's $19.7 billion budget. But agency science officials are forecasting flat budgets for physics and other fields—meaning reduced buying power and no facility improvements. The outline also promises careful scrutiny of unnamed "major" science projects, raising fears of delays at the Spallation Neutron Source, under construction at Oak Ridge National Laboratory in Tennessee.

• **USGS:** Intensive lobbying from agency officials and outside interest groups has prompted the White House to cut in half a proposed 22% drop in USGS's $883 million budget. But even an 11% cut, says USGS director Chip Groat, means "we're going to have to [lay off] people." Groat is also worried about language calling on the agency to "better target" its contribution to managing national parks and lands. The words suggest that programs not specifically tied to federal lands—from stream-gauge networks to seismic monitoring—"would be out the door," Groat says. The one morsel of good news is that a rumored effort to shift scientists in USGS's Biological Resources Division to other Interior agencies appears to have lost steam after objections from Congress.

• **EPA:** A roughly flat overall budget (after removing pet projects added by Congress) is likely to mean level funding for its $696 million science and technology account. The outline is silent on the fate of the Clinton Administration's Climate Change Technology Initiative.

• **USDA:** Bush expressed support for agricultural research in the final presidential debate in St. Louis, and his budget calls for investing in biotech and new products. The agency's main extramural grants program, the $106 million National Research Initiative, is hoping for a small raise. **–DAVID MALAKOFF**

With reporting by Jeffrey Mervis and Jocelyn Kaiser.

BOTANY

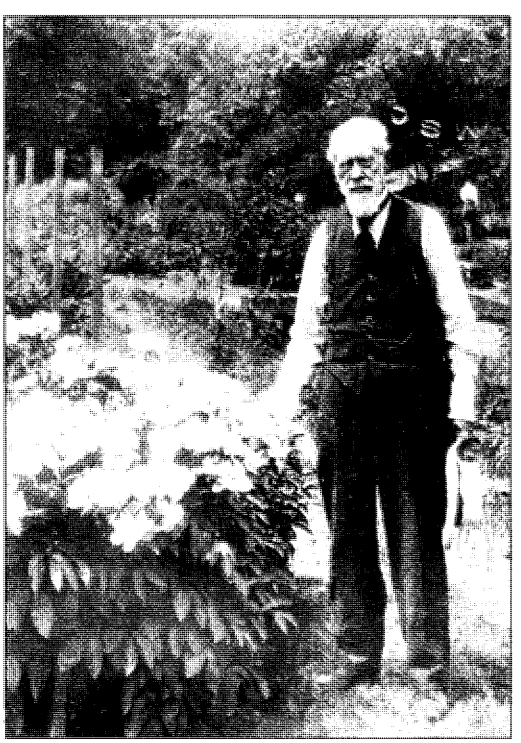
Patience Yields Secrets of Seed Longevity

After more than a century, the world's longest seed viability experiment keeps on sprouting—and inspiring scientists worldwide

On a brisk fall day almost 122 years ago, Michigan botanist William Beal stirred handfuls of ordinary plant seeds into damp sand and sorted the sand into 20 clear glass bottles. When Beal finished, each bottle was identical, containing 50 seeds from each of 20 plant species. He had a single question: How long can a seed survive in the dark, cold ground, yet still burst into life when blessed by sun or rain? To find out, Beal buried his 20 uncorked bottles mouth down, east to west, on a secret, sandy knoll at Michigan Agricultural College. Every fifth year, he decided, he would dig up one bottle, plant the contents in a greenhouse with light and water, and see which seeds sprouted.

Today, Beal's study—stretched into 10-year, then 20-year increments—has become a tradition at the school, now Michigan State University (MSU) in East Lansing. It is the world's oldest seed viability experiment. Generations of stubbornly sprouting seeds—particularly moth mullein, a European weed crowned with a showy yellow flower—have inspired far-flung researchers, from plant biologists to crop scientists to restoration ecologists. "This is nature's Rip Van Winkle story," says Frank Telewski, an MSU botanist and curator of the W. J. Beal Botanical Garden.

While Beal's seeds sleep, a growing number of scientists have moved beyond his original question to explore the mystery of seed longevity. Why do some plant seeds hang on for decades—even centuries—while others barely survive winter? And how? "Think of this tiny sliver of a seed, just a remnant of a weed," remarks Paul Cavers of the University of Western Ontario in Canada. "How on Earth can it live for so long?"



Green thumb. With cheap pint bottles and common plant seeds, William Beal launched an extraordinary experiment.

CREDIT: MICHIGAN STATE UNIVERSITY

Dark secrets

The secrets of seed longevity lie below ground, in natural seed banks. Being parsimonious, most plant species do not allow their seeds to germinate all at once. Instead, the seeds take turns—some sprout in a given spring or fall, while others sit out for one or many seasons to come. Drab and brown, the seeds attract little attention from predators and subsist on internal sugar stores. Through such tricks, plant populations boost their chance of surviving in a fickle world.

This meager underground existence can last for months—or decades, depending on the seed. Finally, if the soil is turned over at just the right time, meeting a particular seed's unique demands for temperature, light, and water, the plant will burst above ground, announcing its presence. In Holland during World War I, bloody battles and freshly dug graves at Flanders Field uprooted so much dirt that long-dormant poppies suddenly burst into red bloom. It was bitter beauty.

Every so often, a botanist reports finding viable ancient plant seeds in a canoe, say, or inside a tomb, but the estimates of plant age are often hard to confirm. So far, the oldest seed reliably recorded came from a sacred lotus in a withered lakebed in Liaoning, China. The Paozhi Basin lake, whose sediments date back to the Holocene era, had once blossomed with lotus plants cultivated by Buddhist monks. In 1994, scientists at the Beijing Institute of Botany gave Jane Shen-Miller of the University of California, Los Angeles, a handful of sacred lotus seeds. Shen-Miller and her colleagues germinated and radiocarbon-dated the seeds. They estimated one of the seeds to be roughly 1450 years old.

"The secret of the sacred lotus may be its seed coat," says Shen-Miller. "The coat is very hard, built to prevent water and air from entering and degrading the seed." The sacred lotus is also blessed with a hardy collection of repair enzymes, such as L-isoaspartyl methyltransferase and other