tion," says Lansbury.

A clue came when postdoc Kelly Conway found that adding antioxidants to the test tube mix reversed the inhibitory effect of dopamine and sped back up the transformation of α-synuclein from protofibrils to fibrils. The dopamine that sends neural messages, which people with Parkinson's disease lack, is stored in synaptic vesicles and protected from oxidation. But dopamine is formed in the cytoplasm, and while there it's easily oxidized. Because the oxidized form of dopamine has been implicated in cell death in earlier studies, and because of his team's new work with antioxidants, Lansbury speculates that the balance between dopamine and its oxidized form goes awry in Parkinson's patients. Perhaps, he says, dopamine is not promptly moved to the vesicles and languishes instead in the cytoplasm, where it's oxidized and sustains protofibrils.

Others researchers are intrigued: "It's a new way of thinking about the basis for Parkinson's disease … one that ought to be pursued," says Jeffery Kelly, a chemist at the Scripps Research Institute in La Jolla, California. Virginia Lee, a neurobiologist at the University of Pennsylvania in Philadelphia, says the work complements mounting evidence that protofibrils are harmful and that oxidative stress helps stabilize them.

Because all three forces—α-synuclein, dopamine, and oxidative stress—are present in some form in normal brains, it remains unclear which is more to blame in Parkinson's. Lansbury's group suspects that a buildup of α-synuclein is the first domino that topples the rest, eventually combining with oxidized dopamine to form protofibrils. Although the theory of excess α-synuclein has not been broadly tested, transgenic mice with excess protein are more likely to develop Parkinson's symptoms.

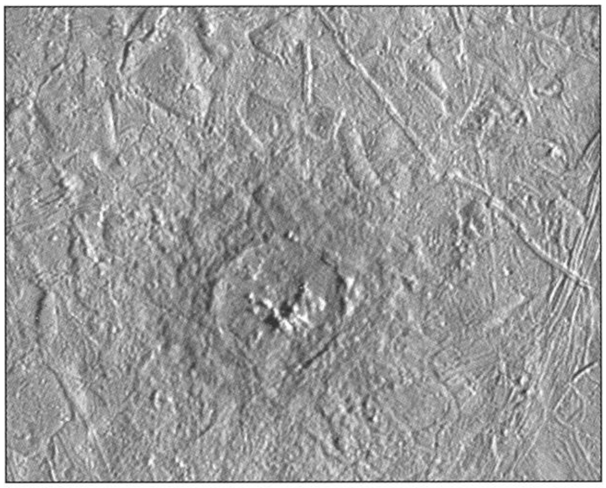
Despite the limitations of studying protofibrils in a test tube, scientists are gingerly discussing the study's implications for treating Parkinson's. Many patients currently take a drug called L-dopa, which passes through the blood-brain barrier and there converts to dopamine. If the Lansbury team is correct, say neurobiologists such as Teresa Hastings of the University of Pittsburgh, giving cells more L-dopa could be counterproductive: Some neurotransmitter may get oxidized, sustaining protofibrils and allowing them to kill cells. Studies thus far have not deemed L-dopa treatment harmful, and it often eases symptoms. Still, researchers have long wondered about L-dopa's long-term effect on brain cells. A clinical trial funded by the National Institutes of Health and based at Columbia University is examining whether L-dopa affects the progression of Parkinson's disease; results are expected in about a year. **–JENNIFER COUZIN**

Jennifer Couzin is a writer in San Francisco.

ASTROBIOLOGY

Putting a Lid on Life on Europa

No earthling would choose to live on Jupiter's satellite Europa. But its deep ocean of liquid water beneath –170°C ice has made the satellite the second most enticing body in the solar system for astrobiologists after Mars. Now that the idea of an ocean is generally accepted, the debate has shifted to how far below the icy surface it lies. If it's too far, even the most tenacious ocean life could be cut off from its best energy source—the sun—and heavily shielded from the prying eyes of astrobiologists. But this issue of *Science* contains discouraging news. New information about how comets punch into Europa's surface suggests that the ice is more than 3 to 4 kilometers thick, not an optimistic 1 kilometer. That poses a greater obstacle for life in Europa's ocean as well as for astrobiologists.



Thickness gauge. Impact craters on Europa having central peaks, as does Pwyll (diameter 26 kilometers), suggest that the ice is more than 3 to 4 kilometers thick.

Researchers have debated the issue through thick and thin. For the past decade or two, most assumed that at least the upper 20 to 30 kilometers of the 100 kilometers or so of water overlying Europa's rocky core was frozen solid. Calculations suggested that heating of the ice by the tidal pushing and pulling of Jupiter might allow such a thick layer of ice while keeping the ocean from freezing from top to bottom.

Some analyses of images returned by the Galileo spacecraft orbiting Jupiter tended to support the thick-ice hypothesis, too. Analyzing images from the mid-1990s, planetary geologist Robert Pappalardo of the University of Colorado, Boulder, and colleagues at Brown University in Providence, Rhode Island, saw "pits, domes, and spots" on the surface that tended to be about 10 kilometers in size and spaced about 20 kilometers apart. The most likely cause of such features, they argue, is deep ice warmed and thus softened by the ocean and set churning slowly toward the surface, like so many puffy clouds on a sunny day. Such convection requires ice at least 20 kilometers thick, the lower part of which would be soft to prevent fracturing from the surface to the ocean. Anything living in the ocean would then need 100,000 years to reach the sustaining sunlight or to receive energy-laden chemicals slowly moving down from the surface, where they are produced by Jupiter's intense enveloping radiation.

But planetary scientist Richard Greenberg and his group at the University of Arizona in Tucson have an alternative model that's more hospitable to possible life. Looking at more recent Galileo images, they see a whole range of sizes and spacings of features corresponding to pits, domes, and spots; to them, that looks like spotty melting of ice right through to the surface rather than the effects of thick, convecting ice. The ice can melt through, they say, because it is only "a few kilometers" thick, at most. San Andreas–like fractures visible in Galileo images also support the existence of liquid water not far below the surface, says Greenberg: "In our model, the ocean communicates with the surface very easily," with ocean water—and any indigenous life—rising through some cracks and being squeezed onto the surface and back into the ocean in the course of every Europan day (3.5 Earth days).

No one is yet ready to say that the Europan ocean can't readily communicate with the surface, but the "ultrathin" ice layer 1 to 2 kilometers thick that is the most optimistic interpretation of "a few kilometers" doesn't square with a new analysis based on Europan impact craters. In this issue (p. 1326), planetary scientists Elizabeth Turtle and Elisabetta Pierazzo, also of the University of Arizona but not part of the Greenberg group, studied the central peaks that form as material flows into the hole formed on the impact of a comet or asteroid. Europan ice, they reasoned, would not have formed central-peak craters if an object had totally vaporized or largely melted through the ice. Computer simulations of large impacts into varying thicknesses of ice suggested that the ice needed to be more than 3 to 4 kilometers thick to form central-peak craters on Europa. "That rules out the

CREDIT: JPL/NASA

very thinnest ice thickness proposed," says Turtle, at least at the places and times Europa's several central-peak craters formed.

Another, stereoscopic analysis of surface forms is yielding even larger estimates of ice thickness. Planetary scientists Paul Schenk of the Lunar and Planetary Institute in Houston and William McKinnon of Washington University in St. Louis have calculated that ice more than 6 kilometers thick must underlie plateaus they have found to rise 0.5 to 1 kilometer in height and pits 0.5 kilometer deep. That "rules out the ultrathin case," says McKinnon, echoing Turtle.

Although the thicker ice thesis seems to be gaining ground, planetary geologist Robert Sullivan of Cornell University acknowledges that the real world is often not as simple as one extreme or the other. Planetary scientist Christopher Chyba of the SETI Institute in Mountain View, California, says he's also leaning in the direction of thick ice, but "we're not going to feel confident until we get there again."

That won't happen anytime soon, however. Budget-strapped NASA has yet to commit itself to a mission to send an orbiter to Europa, which could confirm an ocean from orbit by measuring the tidal squeeze on the satellite. But getting an ice thickness "won't be easy," says one possible participant.

–RICHARD A. KERR

U.S. DEPARTMENT OF ENERGY

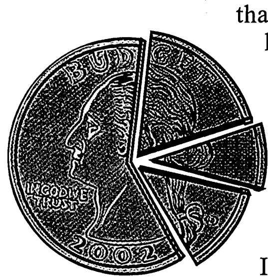
Science Office Grows, Nonproliferation Stalls

It could have been worse. The new science budget for the U.S. Department of Energy (DOE) isn't flat, as the Bush Administration had requested. But Congress has spent much of the 2.5% increase it awarded the department on pet projects, and it squeezed programs in Russia that protect nuclear stockpiles and employ former weapons scientists.

The $25 billion spending bill—approved on 1 November and expected to be signed shortly by the president—includes $3.2 billion for DOE's Office of Science, which is the largest funder of basic physical science programs at U.S. universities and government laboratories. Although it follows the White House budget blueprint closely in most respects, lawmakers restored $10 million for fusion studies and tacked on nearly 10% for DOE's Biological and Environmental Research (BER) program (see table). Legislators, however, earmarked nearly all of BER's $84 million in new money for equipment and construction at specific universities—typically in the home states of senior members of the House and Senate spending panels. There is $11 million, for instance, for the new Mental Illness and Neuroscience Discovery Institute at the University of New Mexico in Albuquerque; the state is the home of Senator Pete Domenici, a top Republican on the appropriations committee.

Given earlier fears of budget cuts, "the bite turned out to be nowhere [near as] bad as the bark," says Scott Sudduth, the Washington, D.C.–based director of government relations for the University of California. Still, researchers "got rather slim pickings if you consider the important role that science plays in national security," adds Michael Lubell, a lobbyist for the American Physical Society in Washington, D.C.

Arms control advocates, meanwhile, failed to increase funding for DOE's nuclear nonproliferation programs. The 2002 budget contains $803 million for arms control programs, $29 million more than the president's request but $69 million less than this year. It also lumps into a single $42 million pot the budgets for two programs—the Initiatives for Proliferation Prevention (IPP) and the Nuclear Cities Initiative (NCI)—aimed at keeping weapons scientists from freelancing for U.S. enemies.



The decision disappointed IPP officials, who had been expecting a substantial increase from last year's budget of $24.5 million, but buoyed NCI backers, who feared Congress would follow the Administration's wishes and practically kill the $27 million

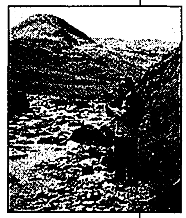
HOW DOE SCIENCE FARED ($ MILLIONS)

	2002 Request	2002 Final	Change from 2001
Office of Science	3159	3233	2.5%
High-Energy Physics	721	716	0.6%
Nuclear Physics	361	361	–
Basic Energy Sciences	1005	1004	1.2%
Fusion Energy Sciences	239	249	–
Biol. & Envir. Research	443	527	9.3%
Advanced Scientific Computing Research	164	158	–4.6%
Other	226	218	–25%

CREDITS: (LEFT TO RIGHT) SOURCE: U.S. CONGRESS; U.S. DEPARTMENT OF THE INTERIOR/U.S. GEOLOGICAL SURVEY, TOXIC SUBSTANCES HYDROLOGY PROGRAM

ScienceScope

Geologic Rebound Things looked grim earlier this year for scientists in the water resources division of the U.S. Geological Survey (USGS). The Department of the Interior had requested a budget that would have cut funding for the National Water Quality Assessment (NAWQA) by 30%, slashed 71% from the Toxic Substances Hydrology Program, and completely eliminated a nationwide network of cooperative research institutes (*Science*, 11 May, p. 1040). Alarmed, groups that use USGS water data—from environmentalists to civil engineers—raised a ruckus.



Now they, and the USGS, can breathe a sigh of relief. When President George W. Bush signed the 2002 Interior appropriations bill into law this week, many of the proposed cuts had evaporated. The toxics and NAWQA programs got 2.3% and 1.6% raises, respectively, while the State Water Resources Research Institutes won a 10% boost. "Compared to the bleak scenario in the spring, things are much better," says David Blockstein, a senior scientist with the National Council for Science and the Environment in Washington, D.C. But he's not optimistic that the water programs will be spared next year, when the federal budget is expected to be even tighter.

Squeaky Wheels The newly signed Interior appropriations bill (see above) also contained mixed news for researchers upset with plans to ax two science centers at the Smithsonian Institution. Last spring, Smithsonian director Lawrence Small announced plans to eliminate the Conservation and Research Center in Front Royal, Virginia, and the Center for Materials Research and Education in Suitland, Maryland (*Science*, 13 April, p. 183). The proposed closures were part of a plan to reorganize Smithsonian science and free up funds for other projects.

After protests from researchers and local lawmakers, Small backpedaled, but warned that Congress would have to come up with more money to keep the units open. It did, giving the Smithsonian $497 million in 2002, $3 million more than the president's request. That's barely enough to cover all the costs of those units, says the Smithsonian's Paula DePriest. And the other science units will take a $1.9 million hit. "It's actually very grim," she adds.

Contributors: Jeffrey Mervis, Jocelyn Kaiser, Erik Stokstad, Elizabeth Pennisi