each of which formed big networks of capillaries. Based on the pattern of impressions in fossilized bone, he suggests that the blood vessels were embedded in mucous membranes lining the walls of the nasal cavity.

What's more, the mucous membranes themselves were apparently extensive. In another talk, a DinoNose collaborator, Scott Sampson of the University of Utah, Salt Lake City, pointed out a number of ridges in the ceratopsian schnozz that probably supported curtains of cartilage; these in turn may have served as scaffolding for layers upon layers of mucous membranes. Yet the most obvious function of noses—smelling—probably wasn't responsible for their size. Smelling takes place at the rear of the nasal cavity, while all the extra space and blood supply is found at the front end of dinosaur noses.

Witmer thinks dinosaur noses helped keep their brains cool. He notes that all the big-nosed dinosaurs had big bodies as well, and for them, heat must have been a problem, because in big animals the ratio of surface area to body mass is much lower than that for smaller animals. As a result, even if dinosaurs didn't have a fast-burning metabolism like that of mammals, the bigger ones must have been unable to shed heat fast enough from the skin to keep their body temperatures from rising to dangerous levels. The brain in particular could have been damaged by such high temperatures, as everyone knows from the occasional tragic stories of teenagers dying from heat-related "brain attacks" after playing sports in summertime.

Witmer proposes that dinosaurs relied on their noses, with their vast networks of blood vessels, to get rid of excess heat. The vessels were probably in contact with the air in the nasal passages and could have wicked heat from the brain. This would be analogous to what happens in mammals, such as the gazelle, that live in hot climates. These animals have veins just under the skin on their head, which cool the blood as they release heat to the air. Rather than traveling straight back to the heart, this cooled blood takes a detour, flowing through a mesh of veins surrounding the brain. These veins run alongside the arteries bringing warm blood from the body's core. The cool veins absorb the heat from the arteries and carry it away from the brain. "Big animals get a big benefit from heat exchange," Witmer says. "It would allow the core temperature to rise while keeping the brain cool."

All this does not rule out other roles for the big noses of dinosaurs. For example, they may have helped attract mates, although Witmer's group has yet to study that possible function. Says Sampson, "We have yet to come up with the final word." **–CARL ZIMMER**

Carl Zimmer is the author of *At the Water's Edge.*

BIOMEDICAL RESEARCH

NIH Eyes Sweeping Reform Of Peer Review

Authors of a reform proposal say their goal is not to make radical changes but to create a system that can be "continually evaluated by outside experts"

Like Lewis Carroll's White Queen, who could believe "as many as six impossible things before breakfast," scientists who analyze the National Institutes of Health's (NIH's) peer-review system often find themselves torn between conclusions that are, at the very least, contradictory: The cornerstone of NIH's success has been its peer-review system, in which small committees of nongovernment scientists, known as "study sections," judge the scientific merit of about 40,000 grant applications a year; *or,* NIH peer review too often amounts to error-prone, turf-conscious nitpicking by obsolete study sections that reject novel ideas out of fear, ignorance, and self-interest.

NIH officials and many researchers today seem to believe both. As a result, NIH is now in the midst of a major drive to refurbish the system—updating it to fit today's biomedical science, setting standards of behavior to improve peer reviewers' manners and methods, and creating a mechanism to ensure that peer review will adapt as science evolves in the future.

In the most dramatic reform proposal so far, a blue-ribbon panel headed by National Academy of Sciences president Bruce Alberts wants to completely restructure the array of study sections operated by NIH's Center for Scientific Review (CSR), which pass judgment on about three-quarters of NIH grant applications (*Science*, 30 July, p. 666).

But the changes that will finally emerge, after they are refined and tested over the next 2 or 3 years, may be considerably less sweeping than the Alberts panel blueprint. "I don't think it's going to be as radically different as some people have said," says NIH director Harold Varmus. "Peer review basically works pretty well now. We don't want to make abrupt changes that could be threats to the system."

The Alberts panel's proposals, if not radical, certainly look pretty startling. Currently, more than 100 CSR study sections are clustered into 19 "Integrated Review Groups" (IRGs), focused mostly around scientific disciplines such as "Biochemical Sciences" and "Cell Development and Function." Instead, in what it calls the "first draft" of its report, the Alberts panel proposes reconstructing the system around 21 reorganized IRGs—16 centered on disease or organ systems and five focused on basic research areas whose application to specific disease areas cannot be predicted.

Basic research that "more directly underlies clinical or applied studies" on specific

What's Wrong With NIH Peer Review?

Among the more than 700 responses to the proposed reorganization of NIH's peer-review system can be found virtually every complaint researchers have ever made about study-section reviews. Here's a sampling:

"I have been on study sections and have seen members who clearly lacked expertise review proposals and grade proposals in a biased, or self-serving, or bad scientific manner." —Louis Gerstenfeld, Boston University Medical Center

***"I have seen the results of ideas being stolen [by peer reviewers]. Who will be believed, the experienced peer or the new investigator?"*—unsigned**

***"Under the present 'culture,' which focuses on fault finding and amplification of minor errors and discouraging innovative research, nearly all NIH funding has gone into confirming, reconfirming, and reinventing what is already known, by individuals of very little insight or talent."*—unsigned**

"Every one of us has received reviews that clearly misstated facts, indicated that the reviewer failed to read the proposal thoroughly, or were filled with unsupported assertions of opinion. Such poorly performed reviews, which are, I believe, all too common, undermine confidence in the system." —unsigned

diseases or organ systems should be peer reviewed "within the broader biological and medical context to which it will ultimately be applied," the panel said. "Thus, we have attempted to place the review of as much fundamental research as possible within the IRG that is most relevant."

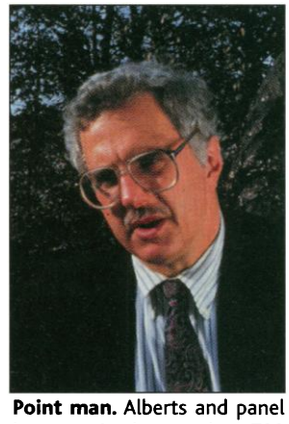
The panel, formally known as the Panel on Scientific Boundaries for Review, did not propose in detail the makeup of the study sections that would populate its revised IRGs. That, it said, is the task for the next phase of the reform effort. But it said there should be enough overlapping expertise so that any grant application could reasonably be reviewed by more than one study section.

Alberts's group offered no suggestions about the study sections run by individual NIH institutes, which generally review applications under specific institute programs. These account for about 25% of NIH grant applications but were outside the range of the panel's study.

The community responds

In an outpouring of more than 700 e-mailed responses to NIH by mid-October, most scientists applauded the Alberts panel's general goal. Many also seized the occasion to vent their own frustrations with the system. But a substantial minority of the comments were skeptical, and many researchers said the panel had left out major scientific areas.

AIDS researchers—who have picked up a lot of political savvy from their activist patients—mounted an organized campaign to retain an AIDS IRG rather than having AIDS research spread among several different IRGs, as the Alberts panel suggests. They enlisted support from such quarters as the Presidential Advisory Council on HIV-AIDS. AIDS was by no means the only research area that scientists complained would be slighted by being folded into a broader IRG. Others included: kidney and urologic research, toxicology, pharmacology, organic chemistry, developmental biology, aging, nutrition, epidemiology, environmental health sciences, and well over a dozen more.



Point man. Alberts and panel have received more than 700 comments on their proposal.

"Please don't destroy the current system without considering the problems that the proposed changes will create," wrote Ronald Breslow, chemistry professor at Columbia University and past president of the American Chemical Society. Weaknesses in the current system can be fixed by less traumatic, targeted repairs, many other scientists said. "The bus is running just fine," wrote biochemist Daniel Kosman of the State University of New York, Buffalo. "If it is missing a few stops, just change the route; don't buy a new model that may not run at all." (*Science* obtained the responses—some signed, most unsigned—through a Freedom of Information Act request.)

But Alberts insists, "We didn't change everything by any means." He says "one of the big misunderstandings" is a belief that his panel began to rearrange study sections, but "that's going to be done by a whole bunch of subpanels of experts in each area." Alberts's panel will meet next week to review the responses and adjust its proposed framework "to make it better," he says.

The Alberts panel's proposal is only the latest—albeit the most sweeping—of a series of peer-review changes that have been set in place or proposed over the past few years. CSR already has gathered neuroscience and behavioral research into four new IRGs, made up of 37 reconfigured study sections, to complete the merger of the National Institute of Mental Health, the National Institute on Drug Abuse, and the National Institute on Alcohol Abuse and Alcoholism into NIH. It created another new IRG, with eight study sections, to centralize review of AIDS research applications and added a special study section for vaccine research. CSR also has fashioned new study sections to handle applications from clinical researchers who feel they don't get a fair shake in panels dominated by laboratory researchers and to provide homes for research proposals that don't seem to fit anywhere else, such as bioengineering collaborations.

The realignment of neuroscience and behavioral study sections—which was required by the 1992 law that merged most of the former Alcohol, Drug Abuse and Mental Health Administration into NIH—started in 1997 and pioneered the technique that will be used if some of the Alberts panel proposals are finally adopted: Advisory groups including extramural researchers worked out tentative organization plans, and then CSR officials performed "test sorts"—assigning batches of actual grant applications among the proposed study sections—to see how the system would work in real life.

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"When one rebuts a review today, the rebuttal is referred to the SRA [scientific review administrator] for the study section that produced the potentially unfair review. This SRA then decides whether the rebuttal is correct. Not surprisingly, she typically decides that it is 'a mere scientific disagreement.'... Unscientific grant review rhetoric never receives objective scrutiny." —Michael Swift, New York Medical College

"Often I cannot recognize even one so-called expert in my area in the study section. The reviewers are pedantic and pay attention to one or two experiments which the reviewer does not understand and shoot down a 4-year project. The reviewers often do not understand the underlying principles or broad objectives of a proposal and resort to nit-picking. Basically all new ideas are rejected." —unsigned

"I do not think any major change has taken place [in study sections' over-reliance on preliminary data]. Preliminary data is still a major barrier. Risk-taking in general is much frowned upon. I remember participating in a study section which reviewed high-risk grants. If I remember correctly, most, if not all, were disapproved as being too unlikely to succeed." —David Greenberg, Mt. Sinai Medical Center, New York

"We do everyone an injustice by allowing half the participants in the process (the reviewers) to hide behind the veil of anonymity. Grants should be reviewed openly and there should be an opportunity to respond to the reviews in 'real time.'" —Donald Dwyer, LSU Medical Center

"The AIDS and Related Research [3] Study Section was composed of individuals with widely different areas of expertise. ... For the most part, we couldn't understand the reviews written by other members of the panel and were able to function only because we were forced to trust each other. Trust is a wonderful thing in friendship but not necessarily in peer review."
—Kathlyn Parker, Brown University

"We have had grants reviewed by a given committee and then upon resubmission, the critique was the exact opposite of the previous panel. ... This is totally unfair and leads to incredible frustration." —unsigned

"We all know how the system works. Do the work, describe part of the results as preliminary in the grant [application], then when you get the priority score, write the papers and start on what you really wanted to do in the first place." —unsigned

Judging merit

Study sections' marching orders have changed, too. In 1997, Varmus ordered peer reviewers to consider "innovation" as one of their explicit criteria in weighing grant applications. He was trying to break study sections' habit of favoring "safe science"—incremental projects using tried-and-true methodology—over more imaginative but riskier proposals that might pay bigger dividends.

CSR director Ellie Ehrenfield and CSR Advisory Committee chair Keith Yamamoto, of the University of California, San Francisco, say that progress has been made but the job isn't quite done yet. "We're trying to make a shift in reviewers' mind-sets," Ehrenfeld says. "We're trying to change people's behavior. None of these things will be solved by a single magic bullet." The problem is an old one. Newly named Nobel Prize–winner Günter Blobel of The Rockefeller University in New York City recalls (with a laugh) that in 1986, an NIH study section trashed a proposal of his as impractical, "and I found the critiques not constructive but offensive." But Blobel emphasizes that the NIH peer-review system "is a very good one," and he says most of its decisions are right.

NIH also has simplified grant applications—and reduced opportunities for reviewers' second-guessing—by ending the requirement for detailed budget plans in most "investigator-initiated" grant applications. Under the "modular grant" and "just-in-time" approaches, researchers in most cases simply ask for funding in increments of $25,000; detailed budget justifications and many other paperwork requirements don't come until after a grant is approved. Additional changes are in the works—although some have been a long time coming.

"No matter how we organize study sections, what really matters is the people sitting around the table," says Ehrenfeld. Thus CSR is trying to broaden study-section recruiting and has experimented in an informal way with several devices to make peer-review service less onerous. These include tours of duty that involve less than the conventional three meetings a year for 4 years and shared assignments that allow scientists to substitute for one another at some meetings. But none of these changes has been implemented in a systematic way.

CSR officials, and Varmus, also are still puzzling over how to lure more senior scientists back onto study sections. This could bring more consistency and credibility to the process, they say, but senior scientists are generally unenthusiastic about the idea. "They've done it before," says Varmus, "and they're on to other kinds of advisory activities, some of which are probably more fun and less work."

Varmus himself, of course, will be eligible for study section service next year, after he leaves NIH to become president of the Memorial Sloan-Kettering Cancer Center in New York City. Will he volunteer?

"Volunteer?" he replies. "No. But if they call me, I'll think it over."

Since 1996, Yamamoto and others have been pushing another idea that is just now taking effect: oversight by "IRG Working Groups." These will be teams of eight to 10 extramural researchers who will attend at least one round of peer-review meetings, monitor the activities of their IRG and its component study sections, and offer advice on whether the scientific boundaries between study sections are still appropriate—as well, no doubt, as on the conduct of reviews. In effect, they will peer review the peer reviewers. If they can exercise enough diplomatic skill to avoid friction with study section members and chairs, they may provide a mechanism for adapting the peer-review system as science evolves. Alberts is counting on the IRG Working Groups to keep the system up to date. He sees this as a "great once-in-a-lifetime opportunity to create a system that won't be just locked in place, but can continually be evaluated by outside experts—and in which modern science, which is changing so rapidly, can really be adequately be supported and tracked." The first three IRG Working Groups are already on the job. Five more are in the planning stage.

For individual researchers, however, the biggest boon may come from more efficient communication through the Internet. NIH officials say they are only a year or two away from establishing a long-sought system of electronic submission and review of grant applications that could slash by nearly one-half the 10-month lag from submission to award. Doing away with time lost to printing, collating, distributing, and mailing grant applications also might enable researchers to submit revised proposals without missing a grant-award cycle.

Whatever the outcome of the Alberts panel recommendations, peer review is changing. And perhaps it should be no surprise that the process is taking longer than anyone would like. "This really is like turning a big ship," Yamamoto says. "Ellie is trying to do a lot of things at the same time, with a staff that's already overburdened."

Will Varmus's departure in January slow the momentum? Yamamoto hopes the loss will be limited. "He's put the ship in the right direction," Yamamoto says. "Inertia can be a friend here." **–BRUCE AGNEW**

Bruce Agnew is a writer in Bethesda, Maryland.

SCIENTIFIC MISCONDUCT

The Misconduct Case That Won't Go Away

The University of Arizona fired Marguerite Kay last year, but supporters nationwide are rallying to her cause and a legal decision is pending

A contentious scientific misconduct case that has divided faculty at the University of Arizona may be heading toward a new climax. This month, an Arizona state court is considering a request by the accused—a prominent researcher on aging, Marguerite Kay—to be reinstated as Regents Professor at the University of Arizona (UA), Tucson. University president Peter Likins dismissed Kay abruptly on 15 July 1998 after a series of faculty-led investigations concluded that Kay had manipulated data and seriously mismanaged her lab. Kay has appealed the dismissal to the state court, which issued a decision partly in her favor on a different legal basis in April. The current appeal could be decided in a few weeks.

Kay, cited for her research on the aging of blood cells and the role of the immune system in Alzheimer's disease, has enjoyed the continuous support of a vocal contingent of the faculty. Her foremost advocate is her former department chair, John Marchiolonis, head of microbiology and immunology. He insists that the scientific misconduct charges against Kay were played up by administrators who resented Kay's challenges to their decisions on lab resources and service fees.

Former UA vice president for research Michael Cusanovich, who coordinated the initial Kay investigation, says these allegations are unfounded. The inquiry, he says, began when one of Kay's former technicians filed a written complaint with the university, and the investigation was conducted by independent panels selected by the faculty, in accordance with UA rules. Marchiolonis and Carol Bernstein—a