million donation. While Soros promises to continue ISF's support for libraries and telecommunication links, he intends to bankroll further research grants only if funds are found from other sources.

So far, the sole response to this threat has come from the Russian government, which in March promised $12.5 million. Together with a matching sum from Soros, this will allow for a 6-month extension to existing ISF grants, seeing their holders through to the end of 1995. Beyond this period, Soros told *Science* that he wants to provide around $12.5 million a year for ISF, but only if Western and former Soviet governments chip in to raise the foundation's overall annual budget to between $50 million and $60 million. Former U.S. genome project head James Watson, ISF's executive chairman, has been placed in charge of the fund-raising effort. Now that ISF has proved itself capable of managing a grant round, he says, "this is the time to try and raise additional money."

While Watson attempts to win support for ISF, the Brussels-based managers of INTAS are lobbying to save their program. The original idea was to bankroll INTAS with funds from the European Union's own research budget and direct support from the governments of the union's 12 member nations, explains Rainer Gerold, director of international scientific cooperation at the European Commission, the union's executive body. But so far, 95% of INTAS' budget has come from the union's central coffers. And with Gerold's budget for international collaboration slated for major cuts after 1995 (*Science*, 25 March, p. 1675), INTAS could find its budget slashed in half. If individual European nations do not begin to contribute soon, says Gerold, INTAS may be forced to stop funding grants and concentrate on cheaper activities such as workshops.

Every Russian researcher now leaning heavily on support from ISF and INTAS faces a personal disaster if the two bodies' fund-raising efforts fail. And many Russian scientists see the problems facing these programs as symptomatic of the wider picture of aid to Russia. Now, notes Moscow State University molecular biologist Vladimir Skulachev, Western politicians are having second thoughts about donating money to Russia, fearing a resumption of Cold War hostilities if Zhirinovsky is successful in his planned bid for the presidency in 1996. The danger, says Skulachev, who co-chairs ISF's Russian advisory committee, is that these concerns could become self-fulfilling: If the West now turns its back on Russia, he argues, "for sure we will have Zhirinovsky, or somebody like him."

–Peter Aldhous

With additional reporting by Daniel Clery and Andrey Allakhverdov, a science writer in Moscow.

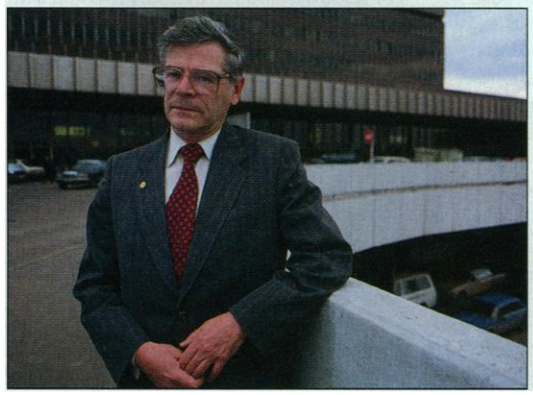
BIOLOGY

Elite Groups Struggle on With A Little Help From the West

MOSCOW AND PUSHCHINO—In the late 1980s, biologists seemed ready to shake off their reputation as the poor relations of Soviet science, forever overshadowed by their better known colleagues in physics and mathematics. Over the previous quarter of a century, the country's molecular biologists had slowly but surely built up a handful of world-class institutes, and with the advent of Mikhail Gorbachev's *perestroika* reforms, suddenly anything seemed possible. Indeed, in April 1989, when the U.S.-based multinational Monsanto announced a 3-year, $1.5-million deal to set up a joint biotech lab in Moscow with the showpiece Shemyakin Institute of Bioorganic Chemistry, it seemed that Soviet molecular biologists were at last going to emerge from the shadows.

The long-awaited golden age of Soviet biology was, however, cruelly derailed by the disintegration of the Soviet Union and the failure of Russia's nascent market economy to get off the ground. But while these events have left Russian physics, for instance, in a state of near total paralysis, the mood at the country's small cadre of elite biology institutes is somewhat brighter. One reason: Grants from Western bodies such as U.S. financier George Soros' International Science Foundation (ISF) are now allowing the best scientists to continue their experimental work. "It's a hard life. It's a difficult time. But it's possible to do science," says Andrei Mirzabekov, director of the Engelhardt Institute of Molecular Biology in Moscow, which is leading the way in adjusting to the harsh new economic reality (see box).

Survival tactics. One important advantage enjoyed by molecular biologists is that their "small science" experiments do not require huge sums of money. A typical ISF grant of around $15,000, for example, goes some way toward keeping a small team working at the bench. Another factor behind the guarded optimism expressed to *Science* by senior Russian biologists is that they have a long experience of battling through adversity. As many point out, Soviet biology came perilously close to destruction in the 1940s and '50s at the hands of Trofim Lysenko, the infamous president of the Soviet Academy of Agricultural Sciences.



PHOTOS BY GEORGE DE KEERLE/SYGMA

Views from the top. Alexander Spirin *(above)* of the Institute of Protein Research warns of impending crisis; Eugene Sverdlov *(top)* of the Institute of Molecular Genetics favors sending young researchers abroad.

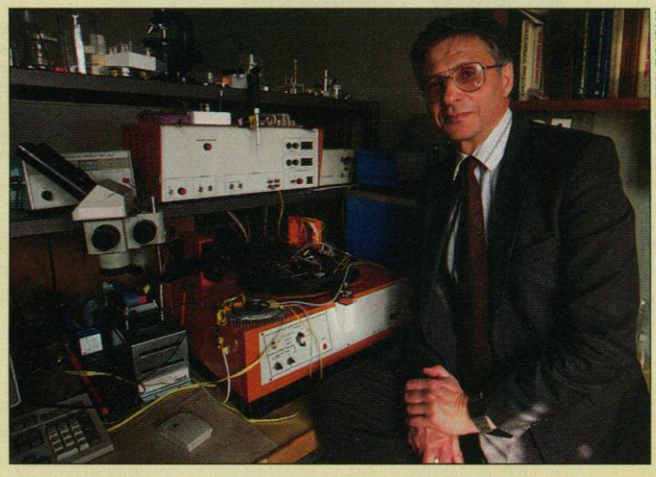
Lysenko promised Joseph Stalin that he could overhaul the country's farm system by applying Lamarckian evolutionary ideas to plant breeding—the premise being that characteristics acquired from environmental conditions could be passed on to subsequent generations. Lysenko's pseudoscience yielded little in the way of better crops, but he filled the gulags with able researchers who opposed his theories, and he drove conventional Mendelian genetics underground.

Given this brutal suppression of the cornerstone of modern biology, it's surprising that Russia now possesses any world-class molecular biology centers. The fact that it does, biologists here agree, is partly due to the covert support provided by their physicist colleagues during the height of Lysenko's power. Take the Institute of Molecular Genetics (IMG) in Moscow, founded in 1959 as the radiobiology department of the Kurchatov Institute of Atomic Energy: "This was just a cover," says

An Outward-Looking Institute

MOSCOW—Andrei Mirzabekov, director of the Engelhardt Institute of Molecular Biology, says he first saw the handwriting on the wall in the mid-1980s, shortly after Mikhail Gorbachev took power. At that time, many Russian biologists were anticipating a bright future as the reforms of *perestroika* took hold. But Mirzabekov says he saw a darker side to the otherwise welcome political changes. In a country where research spending had been closely tied to support for the huge military-industrial complex, he says, the end of the Cold War posed a serious threat to science.

Today, staff members at the Engelhardt Institute have reason to be thankful for Mirzabekov's forebodings. Fearing a collapse of government science funding, Mirzabekov set about reinventing his institute as an internationally oriented center—giving its scientists an important advantage in the current scramble for Western grant support. And taking this approach to its logical conclusion, Mirzabekov last year took the novel step, for a Russian biology research center, of convening an 11-person international advisory board to help frame his institute's plans. The board, moreover, consists of some of the best known names in molecular biology, including Nobelists Paul Berg of Stanford University and Harvard University's Walter Gilbert.



GEORGE DE KEERLE/SYGMA

Smart money. Andrei Mirzabekov's work on DNA chips is making an impact abroad—and bringing in Western funding.

Mirzabekov's strategy has already yielded significant returns: Two thirds of the Engelhardt Institute's 38 research teams now hold foreign grants. And this achievement, he believes, stems partly from the dismantling in 1988 of the institute's internal hierarchy, giving its group leaders genuine independence—and with it the responsibility to drum up their own research support. Meanwhile, heavy pressure has been put on researchers to publish in top Western journals. "Without publications abroad," says Mirzabekov, "no one can be promoted [internally]."

Another key factor in the Engelhardt Institute's success in winning foreign funds is a major project headed by its director. Mirzabekov is one of the pioneers of sequencing by hybridization, a radical approach to DNA sequencing that relies on observing through a microscope the pattern formed when an unknown sequence binds to a glass "chip" carrying an array of short pieces of DNA representing all possible sequences of a given length (*Science*, 27 September 1991, p. 1489).

Competitors say that Mirzabekov's group is still a force to be reckoned with, despite their difficult working environment. "They're developing new chemistry," says Oxford University biochemist Ed Southern. Indeed, the group's contribution has been recognized by several Western agencies: The U.S. Department of Energy, for instance, provided a 2-year, $110,000 grant last year; and other organizations including the DNA chip company Affymetrix of Santa Clara, California, have also pitched in with significant financial support. Mirzabekov has even tapped into two formerly closed Russian military institutes, which are making a fluorescent microscope fitted with ultra-sensitive charge-coupled device cameras for a fraction of the cost of similar Western equipment. Such a device is needed to visualize the pattern of hybridization on a small DNA chip.

Despite these successes, Mirzabekov accepts that there is a long way to go before the Engelhardt Institute's survival is assured. And that, says Berg, is where the international advisory board can help. Aside from reviewing Mirzabekov's research plans, Berg aims to act as an advocate for the institute, pressing for further Western funding. Such high-powered international support is good news for Mirzabekov. But ultimately, he stresses, the institute's future prosperity lies in the hands of its own scientists: "We understand that survival is our responsibility."

–P.A.

IMG director Eugene Sverdlov. "People worked from the beginning on molecular genetics and DNA structure."

Nevertheless, even when Lysenko was removed from power, biology still did not attract the generous funding poured into the physical sciences. During the 1960s, established Moscow centers like the Engelhardt and Shemyakin institutes were joined by new facilities in Pushchino, some 100 kilometers south of Moscow, and Novosibirsk, in the heart of Siberia. But it was not until the early 1970s that the then-director of the Shemyakin Institute, Yuri Ovchinnikov, caught on to the one sure-fire way to draw large sums of money for science from the Soviet authorities: Convince them that your work has important military applications.

By stressing the potential of biological weapons and cozying up to Communist party powerbrokers, Ovchinnikov won major funding for molecular biology until his death in 1988. Today, Russian biologists have mixed feelings about Ovchinnikov's influence, pointing out that he was an autocratic figure who poured much of this money into a single grandiose project: the construction of palatial new quarters for his own institute, fitted with everything from a pilot biotech production plant to a swimming pool. Nevertheless, the result is certainly impressive. Today, the renamed Shemyakin and Ovchinnikov Institute, consisting of 13 buildings that in aerial view describe a huge DNA double helix, dominates the shabby suburbs that surround it in south Moscow. "It's the Taj Mahal of biology," observes Valery Soyfer, a former IMG molecular biologist now at George Mason University in Fairfax, Virginia.

Despite the jealousy caused by Ovchinnikov's blatant feathering of his own nest, Soviet molecular biology approached the 1990s in a buoyant mood. Indeed, when Gorbachev responded positively in 1989 to a request from the Engelhardt Institute's Alexander Bayev—a biologist who was jailed for 17 years in the Stalin era—to set up a Soviet arm of the international Human Genome Project, past problems seemed long gone.

The optimism abruptly turned to despair, however, with the disintegration of the Soviet Union. Russia's current economic woes have brought about a sudden collapse in

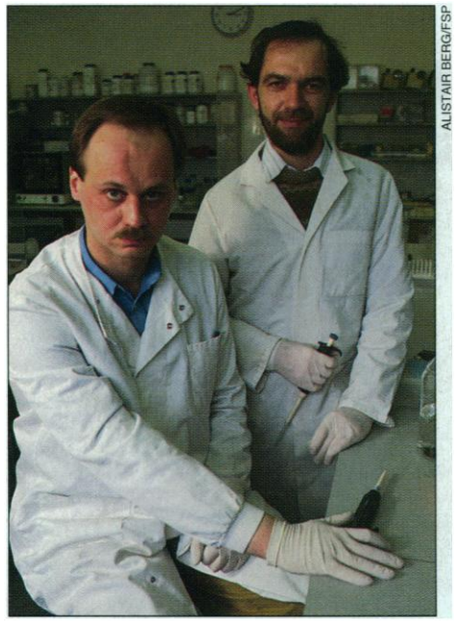
funding that threatens to accomplish what Lysenko failed to achieve: the destruction of Russian biology. "We are on the edge of crisis," warns biochemist Alexander Spirin, director of the Institute of Protein Research in Pushchino. This time, biologists cannot turn for help to their friends in physics, because all of Russian science is in the same leaky boat. But with the Iron Curtain lifted, Russian biologists are looking further afield for assistance—to foreign biologists. And for some groups, collaborative projects with top Western labs are providing a vital lifeline—helping stem a serious brain drain that has stripped many institutes of their most productive, mid-career researchers.

The emerging pattern is for lab chiefs to send their young protégés abroad for temporary visits of several months' duration. "They work in good conditions, earn some money, and then come back," says IMG director Sverdlov, who is using the tactic to hold together the lab he maintains at the Shemyakin and Ovchinnikov Institute. Molecular biology, fortunately, lends itself to this "shuttle science" approach, as it is often possible to prepare research materials in Russia before taking them abroad to conduct expensive procedures such as nuclear magnetic resonance spectroscopy or x-ray crystallography.

A bonus for the West. But it's not all a one-way street. Many of these collaborative projects are bringing scientific bonuses for the Western participants as well. Take the case of Alec Jeffreys, the Leicester University geneticist who pioneered DNA fingerprinting. Jeffreys is now hosting Yuri Dubrova of Moscow's Vavilov Institute of General Genetics, who has brought with him blood samples from hundreds of adults exposed to radiation in the 1986 Chernobyl disaster and their children born after the families were evacuated from the area. Jeffreys and Dubrova are continuing a project Dubrova started during his last trip to Britain, when he found that irradiated mice showed a noticeably high rate of mutation in the sections of DNA routinely used in DNA fingerprinting, known as "minisatellite" loci. Now, they aim to see if the same holds true in human populations.

This collaboration, which Dubrova says would have been politically impossible in the Soviet era, may lead to the development of a minisatellite-based technique to monitor genetic damage in people from radiation. Radiation damage has been hard to spot with conventional techniques because both the background mutation rate and radiation-induced increases at most loci are so low that huge sample sizes have been required to detect any radiation effect. "The basic scientific questions are very interesting indeed," says Jeffreys. "This is not a case of collaboration being due to altruism."

Several Western agencies have for a number of years provided money to bring Russian biologists to the West for temporary visits—Dubrova, for instance, has a 1-year fellowship from Britain's Wellcome Trust. Now, Western organizations are finally beginning to provide direct support for research in Russia as well, the most significant being ISF and INTAS, the European Union–backed association set up to promote collaborative projects linking former Soviet and Western European researchers, each working in their own labs.


ALISTAIR BERG/FSP

Beyond aid. Alec Jeffreys *(right)* has gained from work by visiting geneticist Yuri Dubrova on genetic damage from Chernobyl radiation.

The INTAS grants—which will, on average, provide about twice as much money to the Russian participants as those from ISF—are particularly highly coveted. Georgii Georgiev, director of Moscow's Institute of Gene Biology, is the co-holder—with a former student who now has a tenured position in Denmark—of the largest single grant made by INTAS. He expects to receive some $220,000 for his lab over the next 3 years to study genes that influence the spread of cancerous cells from a primary tumor. This is a fortune in Russia, where a researcher's basic salary can be as low as $50 a month. And in late fall, around 50 more Russian biology teams will hit the jackpot when the Howard Hughes Medical Institute announces the grantees under a new program covering Eastern Europe and former Soviet states that will provide each of these groups with about $150,000 spread over a 5-year period.

This good news, however, is tempered by disappointment with the lack of support from commercial sources in the West. Last fall, Vadim Ivanov, director of the Shemyakin and Ovchinnikov Institute, was counting on links with Western industry to help keep his institute alive. But since then, the flagship Monsanto deal has expired—it was extended for only 12 months beyond its original 3-year span—and Ivanov feels the same chill wind blowing through several of his institute's other industrial collaborations. Western companies, he says, had hoped that research links with Russian centers would provide a stepping stone into lucrative markets. But now, he says, given the parlous state of the Russian economy, "they are not so optimistic." Venture capitalists, meanwhile, do not seem ready to invest in Russian biotechnology, says the Engelhardt Institute's Mirzabekov, who would like to organize a joint venture to develop his work on novel approaches to DNA sequencing.

Centers of excellence. Moreover, like their colleagues in every other discipline, biology institute directors are finding that—even if several of their labs are receiving Western grants—there are still insufficient funds to purchase major items of equipment or to pay for the heating and repair of buildings. Irrespective of Western grant support, says Mirzabekov, "I'm sure that not many institutes working in molecular biology can survive." What's needed, he argues, is an effort to concentrate competitive groups into a smaller number of centers that might then receive enough funds to maintain an adequate infrastructure.

Many leading Russian biologists agree, and one favored solution is to seek additional Western funding to create "centers of excellence" to accommodate Russia's leading biologists. Vladimir Skulachev, who heads Moscow State University's Belozersky Institute of Physico-Chemical Biology, says that for $2 million a year, a center housing up to 25 groups could be launched in a new molecular biology building on the university campus that is currently lying idle through lack of funds. Ivanov, meanwhile, is floating a plan to create a similar center at the Shemyakin and Ovchinnikov Institute.

The harsh truth, however, is that no Western agency seems ready to make such a major investment in a single center. So the only solution, Mirzabekov argues, is for Russian and Western funding sources to promote mobility between labs by allowing grant holders to choose where they want to work and fostering competition among institutes to attract the best people. Such a system would go against decades of Russian tradition in which researchers typically stayed at the same institute for their entire careers. While the rewards of such an approach will be a far cry from the golden age that beckoned just a few short years ago, for a few select institutes, says Mirzabekov, it could ensure survival. And that, in the midst of a research system that is literally falling apart, may not be such a bad deal.

–Peter Aldhous