glucose 6-phosphate, thus providing Leloir and his group with their first big achievement. After purification, the structure of the second heat-stable cofactor was established in a remarkable tour de force. The substance turned out to be uridine diphosphate glucose (UDPG), the first sugar nucleotide. The discovery of this new type of substance and of its function in sugar interconversion and in the biosynthesis of complex carbohydrates is the basis for the present Nobel award.

The mechanism by which UDPG participates in the conversion of galactose 1-phosphate to glucose 1-phosphate was established by Kalckar and his co-workers and by Leloir himself. The uridylyl group is enzymatically transferred from UDPG to galactose 1-phosphate, thus giving rise to UDP-galactose. An epimerase converts this nucleotide back into UDP-glucose, and the cycle is restarted. Thus, the role of sugar nucleotides as substrates for monosaccharide interconversion was established.

The initial successes of Leloir's group brought some fame and some welcome financial assistance. The Rockefeller Foundation was the first to help. Of great importance was a grant made by the National Institutes of Health in 1951 and continued until last year, when restrictions in foreign aid forced its cessation.

New sugar nucleotides, UDP-acetylglucosamine and GDP-mannose, were isolated from yeast in Buenos Aires, and soon many others were found in different laboratories. In 1961 40 sugar nucleotides were listed in a review article, and the number now is probably close to 100. The inability to find a function for the new compounds initially caused some despair in the Institute, but indications were already accumulating that these substances might participate in glycosyl transfer reactions. The first confirmation was provided in 1953 by the discovery of Dutton and Storey that UDP-glucuronic acid served as a precursor of glucuronic acid conjugates. During the same year in Buenos Aires the first disaccharide, trehalose phosphate, was synthesized enzymatically from UDP-glucose and glucose 6-phosphate with the use of a preparation from yeast. Shortly thereafter Leloir and his associates reported the enzymatic formation of sucrose and sucrose phosphate. The pathway was now clearly indicated, and soon the synthesis of the first polysaccharide, chitin, was announced by Glaser and Brown, thus providing a function for the elusive UDP-acetylglucosamine. By now the field was expanding in an exponential fashion, and in a few years there were many new examples of the sugar nucleotides' two main functions, namely (i) serving as substrates for enzymes which interconvert monosaccharides, and (ii) acting as donors in glycosyl transfer reactions, thus leading to the formation of glucosides, di- or oligosaccharides, and homo- or heteropolysaccharides. For Leloir this new phase culminated in the discovery of the mechanism of glycogen synthesis, a function previously assigned to phosphorylase. Again, UDP-glucose was the precursor. That was the last discovery to be made in the old house. Soon thereafter Perón's dictatorship was overthrown, and the new government, more benevolent toward science, provided the Institute with much larger premises. The day we left the old lab, Leloir said in a prophetic voice: "We will remember with regret the happy days we spent here!" He was right: in the new building there were no leaking roofs to fix.

The staff of the laboratory rapidly expanded, partly because of the larger space available and partly as a result of an agreement with the School of Science of the University, which increased the number of positions. Leloir himself was appointed Professor Extraordinarius and later was made chairman of the department of biochemistry, a position he recently relinquished to have more time for his research.

Leloir has received many prizes and other honors in recent years, and a continual stream of invitations has caused him to travel with relative frequency. Coming from a family of private wealth, Leloir has donated all of his prize money as well as his professor's salary and many collections of journals to the Institute. Indeed, he is as generous with his own money as he is parsimonious with that of others.

Despite his new activities and the increase in administrative problems resulting from the expansion of the Institute, Leloir has not for a single day interrupted his experiments. New projects dealing with different glycogen synthetases, then the discovery of ADP-glucose as the precursor of starch in plants, and more recently studies on the structure and formation of particulate glycogen have kept him busy. You will find him there, at his laboratory bench.

The world is made richer by the presence of persons like Leloir. With his example he taught many of us a style of life and, with his work, he has enlarged the horizon of human adventure.

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Science Funds: NSF Survey Probes Effects of Shifts in Federal Aid

A report released 15 October by the National Science Foundation provides the first broad scale picture of what has happened to the financing of academic research and science education in this period of decelerating federal support. Titled "Impact of Changes in Federal Science Funding Patterns on Academic Institutions,"* the report confirms the existence of a financial recession in university science activities. And it clearly points out that private institutions are the hardest hit. But it also provides ground for believing that, in general, the situation is appreciably short of the cataclysm routinely depicted by many leaders of the scientific community in recent years. In any case, though interpretations may widely differ, the report—actually a summary that will be expanded upon in a publication probably early next year—becomes at once a basic document for discussing the financial health of science in the universities. (Medical schools, perhaps the most financially

*NSF 70-39, 8 pages, available without charge from the National Science Foundation, Office of Economic and Manpower Studies, Washington, D.C.

Total, federal, and nonfederal funds expended for academic research and education in the sciences. Figures are rounded to the nearest ½ percent. [Tables from NSF 70-39]

	Total institutions			Public institutions			Private institutions		
	Total funds	Federal funds	Other funds	Total funds	Federal funds	Other funds	Total funds	Federal funds	Other funds
	Percent change, fiscal 1968 to 1969 and fiscal 1969 to 1970								
Fiscal 1968 to 1969	+ 7.0	+2.5	+11.0	+ 8.5	+ 5.0	+11.0	+3.5	−1.5	+11.0
Fiscal 1969 to 1970	+ 8.5	+2.5	+13.0	+11.0	+ 5.5	+13.5	+4.0	−1.5	+10.5
Fiscal 1968 to 1970	+15.5	+5.0	+24.0	+19.5	+10.5	+24.5	+7.5	−3.0	+21.5
	Percent change, fiscal 1969 to 1970, by institutions grouped by federal obligations received for academic science, fiscal 1969								
(Millions of dollars)									
Group I ($20 or more)	+ 4.5	0.0	+ 9.0	+ 4.5	+ 2.5	+ 6.5	+4.0	−1.5	+12.5
Group II ($10–$19)	+15.0	+5.0	+20.0	+15.5	+ 6.5	+20.5	+1.0	−5.0	+ 9.0
Group III ($5–$9)	+ 8.0	+5.5	+ 9.0	+ 7.5	+ 6.0	+ 8.0	+8.5	+4.5	+10.0
Group IV (less than $5)	+12.0	+8.0	+13.0	+16.5	+17.0	+16.0	−1.0	−7.0	+ 2.0

battered of science-based academic institutions, are not covered but otherwise the study is comprehensive.)

Covering the two successive fiscal years ending last 30 June, the report draws its data from responses to questionnaires sent to the central administration and science department heads of 100, or roughly half, of the universities in this country that award Ph.D.'s in the sciences. Replies were received from 86 institutions and 700 department chairmen, thus providing the best collection of information yet available on this subject. As summarized by NSF, the major findings were:

- Taking into account *all* sources of financial support, total expenditures for academic science increased 7 and 8.5 percent, respectively, in the 2 years under study. However, there has been a 5 to 10 percent decline in "effective" support since fiscal 1968 because of inflation and increased undergraduate enrollments. The latter, the report states, must be taken into account "because college students at all levels make demands on science education resources."

- Because of an expansion of state support, public institutions are generally faring better than their private counterparts. While both have been affected by the tapering off of federal funds, the public universities "in an overall sense . . . seem to have kept pace with enrollment growth and cost increases." In contrast, private universities suffered not only from their general lack of access to state support, but also from their greater dependence on money from Washington. Whereas half their science funds comes from the U.S. government, the report notes, the public universities derive only one-third of their total from this source.

- Federal funds annually increased about 2.5 percent in each year, but the public institutions benefited most. Their receipts rose about 5 percent, while those of the private institutions declined in each year about 1.5 percent. The shifts were accompanied by a turn to other sources. In fiscal 1970, nonfederal expenditures rose 10 percent in private institutions and 14 percent in the public ones. For the private universities, the chief sources of this growth were tuition and fees, endowment earnings, foundations, and gifts. However, only 3 out of 33 in the survey reported the use of endowment principal. In the public universities, increased state appropriations were the chief source of growth in the nonfederal area.

- Apparently as a result of these financial factors, 28 percent of the private institutions reported a decline

Percent changes in manpower, by field, spring 1968–69 and 1969–70. Figures are rounded to the nearest ½ percent. [NA, not available]

Selected science departments, by field	Faculty				Postdoctorates				Total graduate students		Full-time graduate students			
	Total		Engaged in federal research project		Total		Engaged in federal research project				Total		Supported by federal funds	
	1968 to 1969	1969 to 1970	1968 to 1969	1969 to 1970	1968 to 1969	1969 to 1970	1968 to 1969	1969 to 1970	1968 to 1969	1969 to 1970	1968 to 1969	1969 to 1970	1968 to 1969	1969 to 1970
All selected science departments	6.5	3.5	3.5	0.5	6.5	4.0	NA	1.5	−0.5	0.5	−1.0	−0.5	− 2.5	− 5.0
Chemistry	6.0	4.5	4.5	1.5	1.5	5.5	NA	2.0	−1.5	−0.5	−2.5	−2.5	− 4.5	− 7.0
Physics	8.0	2.5	4.5	−1.0	7.5	2.0	NA	−2.0	1.5	−2.0	0.0	−2.0	− 3.0	− 6.0
Mathematics	5.0	3.0	0.0	−6.0	−4.0	16.0	NA	10.0	−4.5	−2.0	−5.0	−3.0	−10.0	−10.0
Electrical engineering	7.0	3.0	3.5	−1.5	21.0	21.0	NA	24.0	−4.0	2.5	−5.5	2.5	− 5.0	− 7.5
Chemical engineering	3.0	6.0	1.0	4.5	14.5	−3.5	NA	2.5	1.5	−2.0	0.0	−0.5	− 5.5	− 9.5
Biochemistry	5.5	5.5	3.5	1.5	4.5	5.0	NA	5.5	0.0	−4.0	0.0	−5.0	1.0	− 7.5
Biological sciences	9.5	4.0	7.5	2.5	19.0	1.0	NA	1.0	2.5	2.0	2.5	1.0	3.5	1.0
Microbiology	4.5	2.0	3.5	−3.0	6.0	−1.0	NA	−4.5	0.0	−2.0	0.0	−1.0	1.0	− 2.0
Physiology	5.5	5.0	2.0	4.5	9.5	−2.0	NA	−4.0	−1.0	3.5	−2.0	4.0	− 3.5	− 0.5
Sociology	6.5	5.0	6.5	−2.5	*	*	NA	*	6.0	3.0	7.0	5.0	3.5	− 7.5
Economics	8.5	4.5	1.5	6.0	*	*	NA	*	−2.0	6.0	−2.5	4.0	−11.5	− 4.5
Psychology	5.5	2.5	3.5	6.0	22.0	−9.5	NA	−5.0	3.0	3.5	4.0	−1.0	0.5	1.5

* Percentage is not shown because the base number is less than 25.

in science expenditures from between fiscal 1970 and 1969, while cuts were reported by only 9 percent of the public institutions.

- Faculty and postdoctorate appointments continued to increase overall during the period under study, but the rate of change declined sharply. From fiscal 1968 to 1969, the overall growth was 10 percent. In the succeeding year, however, it dropped to 4 percent, and for that same year, 20 percent of the departments reported reductions in full-time faculty.
- Despite an 8 percent drop in federal support for graduate students, enrollments of full-time students declined by less than 1 percent. Among the disciplines, the largest decline—8 percent—was reported by heads of mathematics departments. Chemistry and biochemistry chairmen reported drops of 5 percent. On the other hand, sociology enrollments rose 12 percent.
- On the much-contended issue of whether research funds are being equitably distributed between junior and senior researchers, the study turned for information to department heads, the rationale being that, though they are usually senior researchers themselves, they have a stake in the output of their departments. The report states that in 1970, "an adequate division of funds for junior staff" was reported by 78 percent of the chairmen, a decline of 1 percent from the previous year.

In addition to financial information, the survey solicited comments on the effects produced by changes in federal financial support. The report states that these "showed a high degree of consistency" in complaining of impairments in research and training programs, low morale, and anxiety about the future.

Now that the financial plight of academic science has at last been quantified with some precision, the key question, of course, is whether anyone in a position to do something about it is actually listening. There are hopeful signs that the Congress is at least attentive to arguments that the National Science Foundation should be financially strengthened to take on greater responsibilities. This, incidentally, turns out to be a direct product of the Mansfield amendment. And, to the Senator's credit, it should be recognized that that, after all, is what he had in mind when he attacked the Defense Department for being a mainstay of academic research. Whether the situation and mood can be fruitfully exploited is a separate matter. A key figure in this regard is likely to be President Nixon's newly appointed science adviser, Edward E. David, Jr. David is known to be looking hard into academic science finance and related matters, but he has yet to make his first public statement in this area.

—D. S. GREENBERG

Science Policy: Daddario Panel Urges New Study, Changes in OST

The House Subcommittee on Science, Research, and Development released a report on 1 November recommending major changes in the federal science apparatus and calling for formulation of a national policy that would rescue the scientific enterprise from its present financial uncertainties. The report, entitled "Toward a Science Policy for the United States," was drafted after summer hearings during which the subcommittee heard from many of the elders and leaders of the scientific community. It comes as a final appeal on behalf of that community by science's most dedicated friend in Congress, Representative Emilio Q. Daddario. Daddario decided last spring to become Democratic candidate in the Connecticut gubernatorial race and thus to give up his congressional seat and his chairmanship of the science subcommittee. However, Daddario's successor as chairman of the subcommittee, John W. Davis of Georgia, conducted some of the summer hearings and took part in preparing the subcommittee's report.

In drafting the report, the subcommittee was sometimes thinking bigger than the political realities would seem to permit. Its major recommendations include the following:

- The Nixon Administration should set up a task force to draft a statement of national science policy to be submitted to Congress not later than the end of next year. Neither Congress nor the Administration alone could formulate a "credible, viable national science policy," the subcommittee said. It urged that members of the task force be drawn from both the executive and legislative branches of government, from state and local government, from the scientific community, and from the general public. According to the subcommittee, science policy has been developed in "ad hoc" fashion in the past without a statement "in measured political terms [of] what the government thinks of science and technology, or how it intends to treat them."
- The Office of Science and Technology (OST) in the Executive Office of the President should be separated from any direct administrative connections with the President's science adviser or the President's Science Advisory Committee (PSAC). At present, the director of OST is also science adviser to the President and chairman of PSAC. In the subcommittee's view, OST is pulled in so many directions and kept so busy coping with brush fires that it cannot discharge its statutory obligations to lead in formulating basic science policy and evaluating the overall federal effort in research. OST should, among other things, "develop criteria for the support of basic research by the mission-oriented agencies," which have reduced their support for such research both because of the generally tight budgetary situation and because of the Mansfield Amendment restricting research spending by defense agencies to work clearly "relevant" to their missions. Further, the subcommittee held that OST should submit an annual report to Congress describing the state of research and development in the United States and proposing the next year's programs.
- The National Institutes of Research and Advanced Studies (NIRAS), a new administrative entity proposed by the Daddario subcommittee last April, should be established as soon as possible. This agency would include an institute of natural sciences, an institute of education, and an institute of arts, humanities, and social studies.

The NIRAS administrator, who would be assisted by an "office of priorities and planning," would not be of cabinet rank. But his agency would