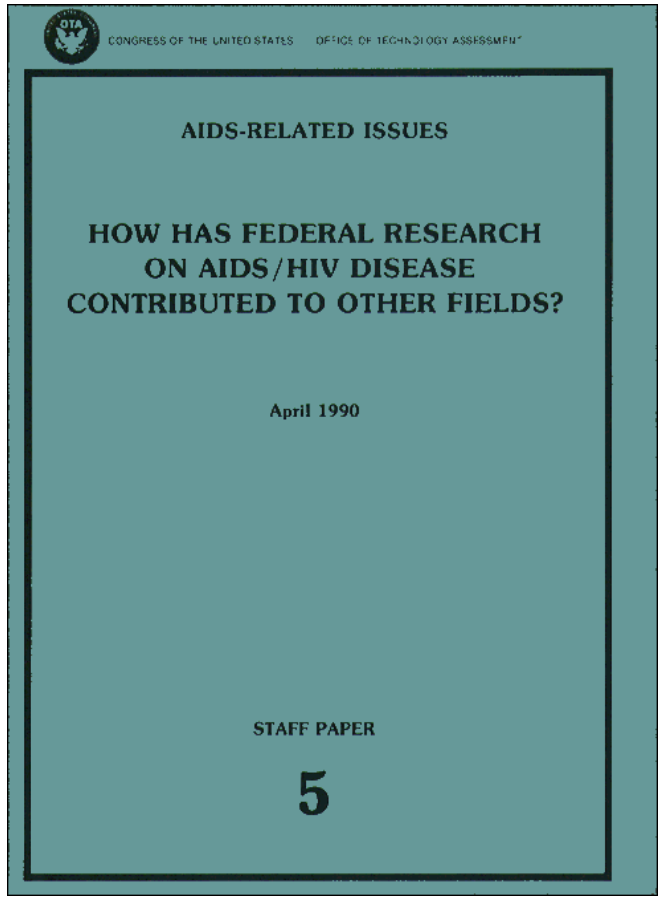
How Has Federal Research on AIDS/HIV Disease Contributed to Other Fields?

April 1990

NTIS order #PB90-253774





HOW HAS FEDERAL RESEARCH ON AIDS/HIV DISEASE CONTRIBUTED TO OTHER FIELDS?

Jane E. Sisk, Study ***Director***
Maria Hewitt, Study ***Co-Director***
Paula Chludzinski, ***Research Assistant***

Other Contributing Staff

Evi Hatziandreu, ***Analyst***
Margaret McLaughlin, ***Analyst***
Carol A. Guntow, P.C. ***Specialist***
Carolyn D. Martin, ***Word Processor Specialist***

Health Program
Office of Technology Assessment
U.S. Congress
Washington, DC 20510-8025

April 1990

A Staff Paper
in OTA's Series on
AIDS-Related Issues

The views expressed in this Staff Paper do not necessarily represent those of the Technology Assessment Board, the Technology Assessment Advisory Council, or their individual members.

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The House Committee on Government Operations, Subcommittee on Human Resources and Intergovernmental Relations asked the Office of Technology Assessment (OTA) to document the extent to which federally funded research on AIDS/HIV has contributed to advances in other fields including biomedical and behavior research, prevention, patient care, and health care financing. In response to this request OTA conducted a survey of distinguished biomedical and social scientists. This Staff Paper reports on the results of that survey.

In February 1990, OTA mailed a questionnaire to a multidisciplinary group of scientists that asked them to rate the contributions of federally funded AIDS/HIV research to advances in 42 different fields that comprised five broad areas: basic sciences, medicine, applied medical sciences, epidemiology, and public health and health services research. OTA also asked the scientists to express their opinions about the current level and allocation of federal funds for research. Thirty-seven percent of 400 scientists asked to complete the questionnaire completed it.

According to OTA survey respondents, significant benefits from AIDS/HIV research have flowed to a wide variety of fields. More than one-half of respondents indicated that AIDS/HIV research had contributed substantially to the basic science fields of virology, immunology, microbiology, and molecular biology. An increased understanding of gene expression, the immune system, viral evolution, and disease susceptibility were among the specific examples of contributions to advances in the basic sciences cited by respondents.

Infectious disease, oncology, neurology, hematology, and pulmonary medicine were medical disciplines cited by at least 40 percent of respondents as having benefited greatly from AIDS/HIV research. Increased insights into mechanisms of dementia and multiple sclerosis, and improved understanding of the development of children's immune systems are among the contributions of AIDS/HIV research to advances in medical research cited by respondents. More than one-third of respondents felt that AIDS/HIV research had contributed substantially to advances in diagnostics, drug development, other therapeutics, and vaccine development.

In the areas of public health and health services research, OTA survey respondents indicated that AIDS/HIV research has led to improved epidemic-modeling techniques, has furthered the development of new methods for the conduct of clinical trials, has stimulated research on health behavior change, and has provided prototype programs for targeting health education to high-risk populations. Furthermore, AIDS/HIV research was cited as having stimulated research on community-based models of care, clarified routes and mechanisms of sexually transmitted disease, provided insights into the effectiveness of drug treatment programs, and improved our understanding of social stigma and prejudice.

Nearly one-half of respondents indicated that Federal spending for AIDS/HIV research was about right and nearly one-third felt that spending was too low. A near equal proportion agreed as disagreed (48 vs. 44 percent) that too much of available research funding has been diverted to AIDS/HIV research from other fields. Not surprisingly, opinions about the level of Federal spending for AIDS/HIV research vary according to whether the respondent had received Federal funds, and whether those funds were for AIDS/HIV or non-AIDS/HIV research. As those not in receipt of any external funding (nearly one-half of OTA survey respondents) are more likely to be "unbiased" in their opinions regarding funding, their responses are of special interest. Over 80 percent of respondents without external support felt that AIDS/HIV funding is about right or too low, and while more than one-half did not agree, nearly one-third agreed that too much research funding has been diverted to AIDS/HIV research from other areas.

In conclusion, results from the OTA survey indicate that, in the opinion of the scientific community, AIDS/HIV research has made many important contributions to advances in the biomedical and behavioral sciences. This finding is especially noteworthy given that substantial lead time is needed for advances to influence other fields. The dominant sentiment of survey respondents supports current or augmented Federal AIDS/HIV research spending levels. At the same time, opinion was divided on the question whether too much research funding has been diverted to AIDS/HIV research from other fields. The results raise for continued consideration the appropriate allocation of research funds among HIV, other targeted areas, and basic science.

As awareness of the enormity of the AIDS epidemic has grown, Federal funding targeted to AIDS and other HIV disease has increased accordingly. From $8 million in fiscal year 1982, the year after AIDS was frost diagnosed in the United States, total Federal spending for medical care, public health activities, and research related to HIV disease has risen steadily and totals $2.9 billion for fiscal year 1990 (table 1). Over the same period, federally funded research on HIV disease rose from $3 million to $1.16 billion (table 2).

For fiscal year 1991, the President has requested a 7-percent increase in funding for HIV research, a somewhat smaller percentage and absolute increase than in previous years. Although the increase in total Federal funding for HIV disease would slow under the President's budget request for fiscal year 1991, spending for fields other than research would receive a larger share of the total allotment.

From divergent viewpoints, concern has been expressed that the Federal Government is spending too much and that it is spending too little on HIV research, compared with funding for other medical conditions (1,6,7,16). Critics of rising expenditures on HIV disease point out that HIV funding has exceeded funding for heart disease and rivals funding for cancer, despite the much greater number of deaths from these latter diseases. Although HIV funding makes up about 10 percent of the total budget of the National Institutes of Health in fiscal year 1990, it accounts for 47 percent of the budget of the National Institute for Allergy and Infectious Disease (table 3). Although it is unclear whether the most significant breakthroughs for HIV-infected

Table l-Total Federal Expenditures on AIDS/HIV, Fiscal Years 1982-1991
(millions of dollars)

Year	AIDS/HIV expenditures	Percent increase
1982	8	
1983	44	450%
1984	104	136
1985	208	100
1986	507	144
1987	926	83
1988	1,594	72
1989	2,227	40
1990	2,936	32
1991[a]	3,463	18
Total	$12,017	

[a]Figures for 1990 are appropriations requested in the President's budget.

SOURCE: U.S. Department of Health and Human Services, Public Health Service Budget Office (13).

Table 2-Federal Spending on AIDS/HIV Research[a] by Agency, Fiscal Years 1982-1991
(millions of dollars)

Agency/Department	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991[b]
Department of Health and Human Services										
Public Health Service	3	22	57	83	164	317	607	942	1,115	1,209
Department of Veterans Affairs	0	0	2	3	3	6	8	11	14	14
Department of Defense	0	0	0	0	38	22	12	27	34	22
Other	0	0	0	0	0	1	1	0	0	0
Total[c]	3	22	59	86	204	354	626	980	1,163	1,245

[a]Methods used in the preparation of the 1982-1988 figures differ from those used for the 1989-1991 figures. If the 1989 figures were prepared using the same methods as were used for the prior years, the figures would be 815, 14, 27, and O, for the Public Health Service, [b]Department of Veterans Affairs, Department of Defense, and other, respectively.
Figures for 1991 are amounts requested in the President's budget. All other figures are actual appropriations.
[c]Due to rounding, some columns may not add to totals.

SOURCE: 1982-1988 data: Winkenwerder, W., Kessler, A.R, and Stolec, RM. (16); 1989-1991 data: U.S. DHHS, Public Health Service Budget Office (13).

individuals will come through targeted, mission-oriented research or through basic research, targeted HIV research appears to be receiving priority (3,6).

Proponents of greater HIV funding stress that current deaths understate the burden of HIV disease. Perhaps 1 million people in the United States are infected and likely to die from HIV disease, and the disease is spreading at epidemic rates in some populations. Furthermore, AIDS has been concentrated among adults age 25 to 45. From 1987 to 1988, HIV rose from the seventh to the sixth leading cause of years of potential life lost, a reflection of a 30-percent increase in life-years lost in that one year (14). Proponents also view funding for HIV research as a good investment in many other disciplines, since AIDS touches on many basic, clinical, and social sciences.

To provide additional information to clarify this debate, the House Committee on Government Operations, Subcommittee on Human Resources and Intergovernmental Relations, requested the Office of Technology Assessment (OTA) to document the extent to which federally funded research on HIV disease has contributed to advances in other fields. The subcommittee was interested in contributions pertaining to a wide range of fields, including biomedical and behavior research, prevention, patient care, and financing. In response to that request, OTA undertook a survey of biomedical and social scientists. This Staff Paper reports on the results of that survey.

Table 3-National Institutes of Health Expenditures for AIDS/HIV Research, Fiscal Year 1990 (thousands of dollars)

Institute	AIDS/HIV expenditures	Percent of Institute's total expenditures
Cancer	$150,304	9%
Heart, Lung, and Blood	42,056	4
Dental	4,662	3
Diabetes, Digestive, and Kidney	5,320	1
Neurological	16,158	3
Allergy and Infectious Disease	393,083	47
General Medical Science	14,614	2
Child Health and Human Development	26,749	6
Eye	5,533	2
Environmental Health Sciences	4,291	2
Aging	859	< 1
Arthritis and Musculoskeletal	1,238	1
Research Resources	44,558	12
Nursing	987	3
Fogarty International	4,898	29
National Library of Medicine	493	1
Other/miscellaneous	27,729	8

SOURCE: U.S. Executive Office of the President, Office of Management and Budget (15).

OTA'S SURVEY ON CONTRIBUTIONS OF RESEARCH ON AIDS AND HIV TO OTHER FIELDS

In February 1990, OTA conducted a survey of distinguished biomedical and social scientists to examine the contribution that federally funded AIDS and HIV research has made to advances in other biomedical and social science fields. In addition, scientists were asked their opinions about Federal funding of AIDS/HIV research.

Methods

A self-administered questionnaire was mailed to 400 individuals who were randomly selected from a group of 801 scientists.[1] Thirty-seven percent of questionnaires (147/400) were returned either fully or partially completed.[2] Characteristics of the respondents are shown in table 4. The respondents' employment, professional activity, training, expertise, and age characteristics were as follows:[3]

- Employment--Over two-thirds of respondents (67 percent) were employed in non-profit organizations, including universities; 15 percent were employed by Federal or State government; and 8 percent were employed in private business.
- Professional activity--More than one-half (56 percent) of respondents were engaged in research; 40 percent in administration; 16 percent in education; and 16 percent in patient care.
- Training--Nearly three-quarters (72 percent) were physicians, and nearly one-third (30 percent) held a Ph.D. degree.
- Expertise--Forty-nine percent of respondents identified their primary field of expertise within medical disciplines; 18 percent in one of the

Table 4--Employment, Professional Activity, Training, and Age of OTA Survey Respondents

	Frequency	Percent
Primary employer		
Federal or State government	22	15.0
Non-profit organization, including university	99	67.3
Private business	12	8.2
Other	14	9.5
Total	147	100.0
Major professional activity[a]		
Research	79	56.0
Patient Care	24	16.3
Education	24	16.3
Administration	58	39.5
Other	10	6.8
Level of training		
MD only	94	64.0
PhD only	33	22.4
Other only	7	4.7
MD and PhD	9	6.1
MD and other	2	1.4
PhD and other	2	1.4
Total	147	100.0
Primay field of expertise		
Basic sciences	27	18.4
Medicine	72	49.0
Epidemiology	4	2.7
Public health and health services research	15	10.2
Other	16	10.9
Unspecified	13	8.8
Total	147	100.0
Age		
<= 35	2	1.4
36-50	29	19.7
51-65	66	44.9
>=66	50	34.0
Total	147	100.0

[a]Percentage does not sum to 100 and frequency to 147 because some respondents listed more than one activity. Frequencies are out of 147 responses, i.e., n= 147.

SOURCE: Office of Technology Assessment, 1990.

1 A copy of the questionnaire is included in app. A. Information regarding the instrument pilot testing and survey randomization techniques is included in app. B.

2 An additional 39 questionnaires were returned to OTA blank, primarily because the respondent did not feel they had the expertise needed to complete the questionnaire or because they had retired. An additional 5 questionnaires were returned, but were not included in the analysis because they had been completed by someone other than the person asked to complete the questionnaire. If these questionnaires are included, the response rate is 48 percent.

3 Percents may not sum to 100 because some respondents listed more than one response or because no opinion responses are not included (see table 4).

basic sciences; and 13 percent in public health or epidemiology.[4]

- Age--Nearly half (45 percent) of respondents were in the 51 to 65 year age range; slightly over one-third (34 percent) were 66 and older; and one-fifth (20 percent) were 36 to 50 years old.

Survey respondents included both AIDS/HIV researchers and scientists with no professional activities related to AIDS/HIV. Sixty-three percent of respondents were engaged in some AIDS/HIV professional activities, but most of these spent less than 20 percent of their time on AIDS/HIV activities (figure 1). Respondents were less likely to have received Federal funds for AIDS/HIV research than for other research areas. Only 16 percent of respondents received Federal funds to conduct AIDS/HIV research, while slightly more than one-quarter (28 percent) received Federal funds to conduct non-AIDS/HIV research (figure 2). Fewer than 10 percent of respondents received external funding from nonfederal sources for either AIDS/HIV or other research (figure 2).

Results

Contributions of AIDS/HIV Research to Other Fields

Survey respondents were asked to rate, on a scale from 1 to 10[5] the contributions of federally funded AIDS/HIV research to advances in 42 different fields that comprised five broad areas:

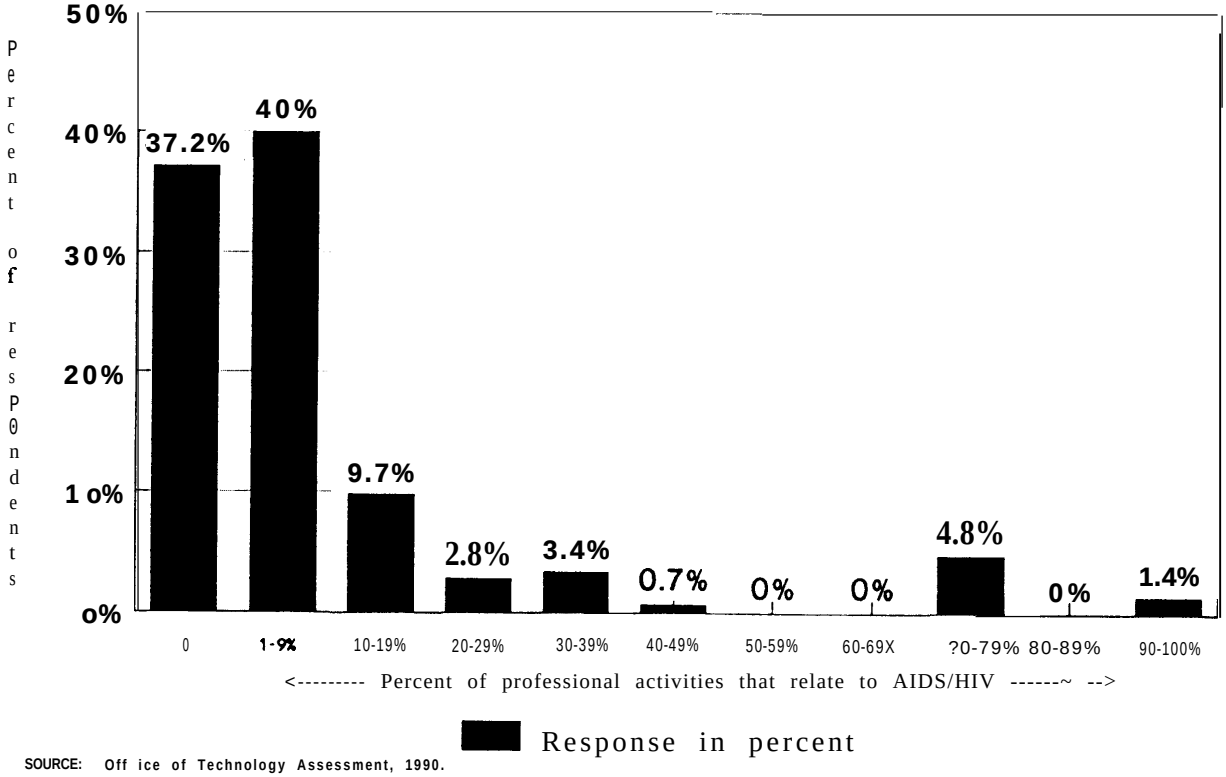
- basic sciences,
- medicine,
- applied medical sciences,
- epidemiology, and
- public health and health services research.

Respondents used the same 10-point scale to rate their levels of expertise for each area.

4Detailed responses to the expertise question are shown in app. D.

5On the 10 point scale 1 indicated "none at all," 5 and 6 indicated "somewhat," and 10 indicated "very much." Zero was used to express "no opinion."

Figure 1--OTA **Survey Respondents' Proportion of Professional Activities That Relate to AIDS/HIV (n=145)**



SOURCE: Off ice of Technology Assessment, 1990.

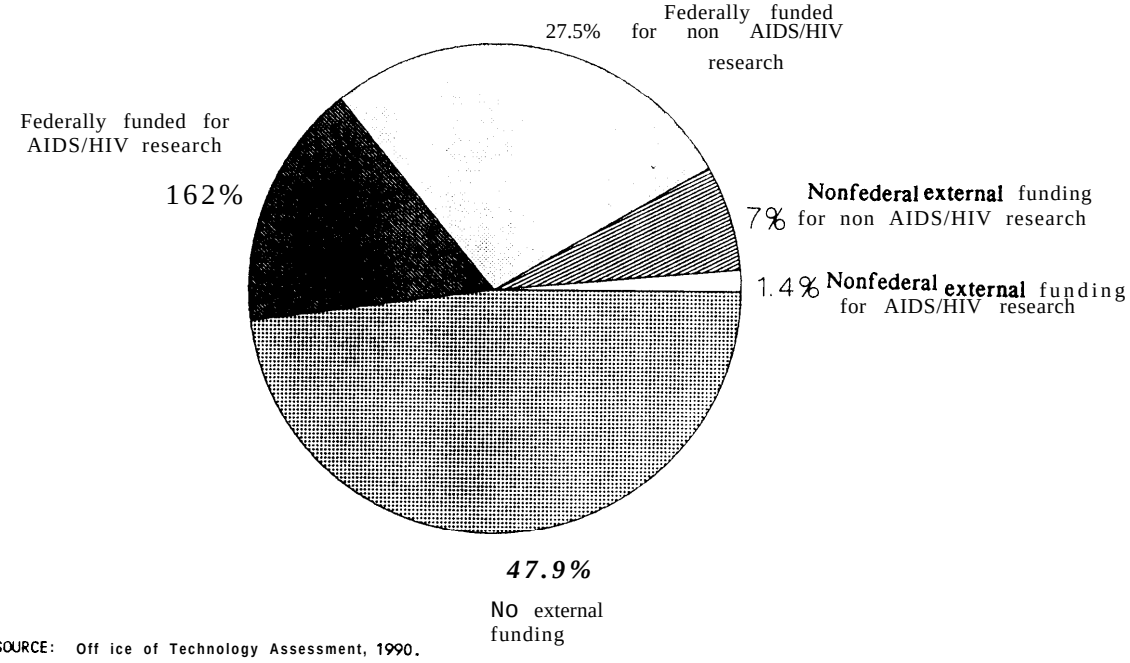
Basic Sciences

The basic science fields reported to have benefited the most from AIDS/HIV research include virology, immunology, microbiology, and molecular biology (table 5). More than one-half of respondents (irrespective of their level of expertise in the field) indicated that AIDS/HIV research had contributed to these fields substantially (i.e., a rating of 7 to 10). Among experts in the respective fields, almost all felt that virology (96 percent) and immunology (94 percent) had benefited substantially from AIDS/HIV research, and nearly three-quarters (73 percent) of microbiology experts indicated substantial benefits in their field. Fields cited most frequently with "little to no" contributions from AIDS/HIV research include genetics, pathology, and biochemistry.

Respondents cited many examples of contributions of AIDS/HIV research advances in basic biological sciences, especially in molecular biology and immunology. Specific examples of contributions of AIDS/HIV research were cited for all basic science fields and are summarized here. Appendix E includes a complete listing of contributions cited by survey respondents.

- Iincreased understanding of the mechanisms by which viral and cell factors control gene expression is broadly applicable to other systems.
- Increased understanding of the immune system, particularly the roles of subsets of lymphocytes and their regulation by cytokines. Knowledge of the intricate relationships among cells of the immune system has facilitated understanding of intercellular communication.
- Studies of the development of new strains of HIV has applications to genetic studies of mutation rates and viral evolution.
- Improved concepts of the pathological consequences of infectious agents, especially in the central nervous system.
- Increased understanding of opportunistic infections and the role of genetic factors that influence susceptibility to infection.
- Improved understanding of the lifecycle of the

Figure 2--OTA Survey Respondents' External Funding, 1989 (n=142)



SOURCE: Off ice of Technology Assessment, 1990.

Table 5-Contribution of AIDS and HIV Research to Advances in the Basic Sciences

Basic sciences	Respondants expertise[a] Number	No opinion	Little to none	Somewhat	Very much	Contribution of AIDS/HIV research[a] according to all respondants Number	Percent: No opinion	Little to none	Somewhat	Very much	Contribution of AIDS/HIV research according to exprts[b] in field Number	Percent: No opinion	Little to none	somewhat	Very much
Biochemistry	116	9.5	49.1	19.8	21.6	112	24.1	22.3	21.4	32.1	48	0.0	37.5	25.0	37.5
Cell biology	117	9.4	50.4	19.7	20.5	114	17.5	15.8	17.5	49.1	47	0.0	19.1	21.3	59.6
Genetics	116	9.5	53.4	19.8	17.2	113	21.2	25.7	20.4	32.7	43	0.0	34.9	20.9	44.2
Immunology	121	9.1	48.8	21.5	20.7	117	12.0	4.3	9.4	74.4	51	0.0	3.9	2.0	94.1
Microbiology	117	10.3	51.3	18.8	19.7	113	18.6	13.3	13.3	54.9	45	0.0	13.3	13.3	73.4
Molecular biology	119	10.1	48.7	23.5	17.6	115	17.4	17.4	13.0	52.2	49	0.0	20.4	18.4	61.2
Pathology	114	12.3	53.5	26.3	7.9	112	25.0	23.2	22.3	29.5	39	0.0	25.6	28.2	46.2
Pharmacology	114	9.6	49.1	29.8	11.4	112	19.6	16.1	28.6	35.7	47	2.1	21.3	44.7	31.9
Virology	115	8.7	51.3	23.5	16.5	112	17.0	0.0	8.0	75.0	46	0.0	0.0	4.3	95.7

[a]Respondents were asked to rate their expertise and contributions of AIDS/HIV research on a 10 point scale with 1 indicating none at all and 10 indicating very much. This table groups responses from 1 to 4 into "little to none," 5 and 6 into "somewhat," and 7 to 10 as "very much."
[b]Experts were those reporting "somewhat" to "very much" expertise (i.e., a rating of 5 to 10).

SOURCE: *Office of* Technology Assessment, 1990,

Table6--Contributlon of AIDS and HIV Research to Advances in the Medical Disciplines

Medical disciplines	Respondents' expertise[a] Number	Percent: No opinion	Little to none	Somewhat	Very much	Contribution of AIDS/HIV research[a] according to all respondents Number	Percent: No opinion	Little to none	somewhat	Very much	Contrbution of AIDS/HIV research according to expertsm[b] in field Number	Percent: No opinion	Little to none	Somewhat	Very much
Cardiology	107	11.2	45.8	24.3	18.7	105	31.4	55.2	10.5	2.9	46	6.5	82.6	8.7	2.2
Dentistry	105	15.2	70.5	10.5	3.8	105	35.2	42.9	13.3	8.6	14	0.0	42.9	35.7	21.4
Dermatology	108	8.3	63.9	23.1	4.6	106	24.5	26.4	23.6	25.5	30	3.3	20.0	26.7	50.0
Endocrinology	106	10.4	54.7	21.7	13.2	103	29.1	47.6	14.6	8.7	37	8.1	62.2	18,9	10.8
Family practice	105	10.5	55.2	17.1	17.1	105	33.3	40.0	13.3	13,3	36	8.3	50.0	22.2	19.4
Gastroenterology	108	9.3	53.7	24.1	13.0	106	30.2	27.4	22.6	19.8	40	2.5	30.0	30.0	37.5
Hemetology	110	9.1	50.9	20.9	19.1	109	22.9	11.9	22.9	42.2	44	0.0	13.6	22.7	63.6
Infectious disease	115	7.8	40.9	21.7	29.6	114	15.8	3.5	10.5	70.2	59	1.7		1.7	93.2
Nephrology	105	10.5	58.1	23.8	7.6	104	28.8	43.3	22.1	5.8	33	0.0	57.6	33.3	9.1
Neurology	113	8.8	53.1	28.3	9.7	111	19.8	22.5	15.3	42.3	43	2.3	16.3	14.0	67.4
Obstetrics/ gynecology	105	15.2	71.4	10.5	2.9	103	32.0	38.8	16.5	12.6	14	7.1	28.6	35.7	28.6
oncology	110	9.1	56.4	18.2	16.4	107	19.6	20.6	15.0	44.9	38	0.0	7.9	18.4	73,7
Ophthalmology	103	14.6	71.8	13.6	0.0	104	39.4	30.8	15.4	14.4	14	0.0	28.6	42.9	28.6
Pathology	106	11.3	55.7	27.4	5,7	106	29.2	18.9	25.5	26.4	35	0.0	17.1	40.0	42.9
Pediatrics	112	12.5	55.4	19.6	12.5	110	25.5	23.6	20.9	30,0	36	0.0	19.4	27.8	52.8
Psychiatry	110	13.6	53.6	19.1	13.6	108	26.9	36.1	12.0	25.0	36	5.6	44.4	8.3	41.7
Pulmonary medicine	106	9.4	52.8	27.4	10.4	105	21.0	16.2	22.9	40.0	40	0.0	12.5	27.5	60.0
Rheumatology	103	11.7	59.2	19.4	9.7	102	32.4	43.1	13.7	10.8	30	0.0	53.3	30.0	16.7

[a]Respondents were asked to rate their expertise and contributions of AIDS/HIV research on a 10 point scale with 1 indicating none at all and 10 indicating very much. This table groups responses from 1 to 4 into "little to none," 5 and 6 into "somewhat," and 7 to 10 as "very much."
[b]Experts were those reporting "somewhat" to "very much" expertise (i.e., a rating of 5 to 10).

SOURCE: Office of Technology Assessment, 1990.

virus, which provides insights into the lifecycles of other viruses, especially other retroviruses.

The elucidation of particular aspects of viral structure and function has applications to studies of other viruses. These include a better understanding of virus uptake by cells, the integration of viral genetic material into the host cell genome, and the mechanism of viral latency.

The results of research on the structure and function of viral enzymes has many applications to other systems. These proteins, encoded by the viral genetic material, catalyze reactions important for the replication of the virus. These studies have been extended into the design of chemicals that inhibit the activity of the enzymes essential to the pathogenesis of the virus. Inhibitors are potential antiviral drugs. This approach to the treatment of viral disease has applications to other viral and fungal diseases and to cancer.

Research on HIV has sparked further experimentation on the treatment of viral diseases in addition to the design of enzyme inhibitors. The approaches being explored include blocking of receptors important for the cellular uptake of viruses, the use of synthetic peptides, and the use of "antisense RNA" in the treatment both of viral diseases and cancer.

Research on AIDS has led to new techniques for the growth and assay of viruses in culture, the development of a mouse model for studying immunodeficiency, and further applications of the polymerase chain reaction.

Research on AIDS has also spurred the development of retroviruses as vectors for gene transfer, the expression of active enzymes in E.coli, the development of tests for toxicity, and the development of diagnostic probes.

Medicine

Infectious disease, oncology, neurology, hematology, and pulmonary medicine were medical disciplines cited by at least 40 percent of respondents (irrespective of their level of expertise in the field) as having benefited greatly (i.e., a rating of 7 to 10) from AIDS/HIV research (table 6). More than one-half of the scientists with expertise in these five medical disciplines also indicated that contributions of AIDS/HIV research had been substantial. More than half of respondents with expertise in pediatrics and dermatology also indicated that AIDS/HIV contributions had been substantial. Cardiology and endocrinology were the medical disciplines cited most often for which AIDS/HIV research had made little to no contribution.

Specific examples of contributions of AIDS/HIV research were cited for all medical disciplines and are shown in appendix E. In general, respondents indicated that AIDS/HIV research has improved our detailed understanding of viruses, viral-induced changes in cell function, and the viral-cell interaction in induction of diseases. In addition, respondents indicated that AIDS/HIV research has 1) enhanced knowledge of the function of the immune system and autoimmune disease (e. g., lupus, rheumatoid arthritis), and 2) provided valuable insights in oncology, such as the mechanism of oncogenesis (e.g., gene control and cell proliferation and regulation), viral etiology of neoplasms, and immunodeficiency -associated cancers. Survey respondents indicated that AIDS/HIV research had improved knowledge in a variety of medical disciplines--neurology, infectious diseases, obstetrics and gynecology, pediatrics, psychiatry--and influenced the applied medical sciences with enhanced knowledge in diagnostics and drug and vaccine development. Specific examples of contributions cited most often by survey respondents were as follows:

Neurology

Increased understanding of blood-brain barrier effects;

Increased knowledge of the role of viruses in central nervous system (CNS) disorders; and

Increased insights into mechanisms of dementia, multiple sclerosis, and degenerative diseases of the CNS.

Infectious diseases

Increased understanding of immunodeficiency-associated infection;

Increased knowledge of opportunistic viral illness;

Detailed understanding of pneumocystis carinii pneumonia (PCP); and

Improved understanding of the transmission of sexually- transmitted diseases.

Obstetn"cs/gynecology and pediatrics

- Improved understanding of maternal-fetal Viral transmission and cell transfer;
- Improved understanding of passive immunity; and
- Improved understanding of the development of the nervous and immune systems in children.

Psychiatry

- Improved understanding of the environment and the social interactions of IV drug users;
- Improved understanding of the use and effectiveness of behavior modification;
- Improved understanding of patients' and families' reaction to terminal illness;
- Increased focus on studies of sexual behavior; and
- Improved understanding of the psycho-social-medical care of complex illness affecting mind, body, and family.

Dermatology

- Improved understanding of the nature of skin pathology in immunodeficient subjects.

Gastroenterology

- Increased knowledge of the mechanism of inflammatory bowel disease.

Dentistry

- Increased understanding of the need for improvements in infection control.

Ophthalmology

- provided new understanding of cytomegalovirus (CMV) retinitis.

Applied Medical Sciences

More than one-half of experts in each of the four applied medical sciences--diagnostics, drug development, other therapeutics, and vaccine development--indicated that AIDS/HIV research had contributed substantially to advancements in these fields (table 7). Drug development was cited most often as having benefited from AIDS/HIV research.

Specific examples of contributions cited most often by survey respondents were as follows:

Diagnostics

- Facilitated development of newer diagnostic tests (e.g., polymerase chain reaction (PCR), radioimmuno assays);
- Facilitated development of rapid diagnostic serologic tests for screening; and
- Facilitated the development of pulmonary diagnostics for viral respiratory illnesses.

Drug development

- Facilitated development of drugs to inhibit viral replication;
- Improved techniques of targeted drug development;
- Facilitated development of antibiotics including antiviral, antiparasitic, and antibacterial therapies;
- Facilitated expedited FDA approval of treatments; and
- Improved treatment of lung infections.

Vaccine development

- Improved basic understanding of vaccines;
- Improved understanding of applications of genetic engineering techniques and recombinant technologies to vaccines; and
- Improved understanding of the development of vaccines against agents that mutate rapidly.

Other

- Development of safer blood banking.

Epidemiology

More than one-half of all respondents and three-quarters of experts indicated that AIDS/HIV research had contributed substantially to disease surveillance and understanding the natural history of disease (table 7). Nearly one-half of respondents with expertise in biostatistics felt that AIDS/HIV research has made substantial contributions to their field, but more than one-third indicated that AIDS/HIV research had made little to no contribution to this field.

Specific example of contributions of AIDS/HIV research to epidemiology cited by respondents included:

- Improved epidemic-modeling techniques;
- Development of new methods for the conduct of clinical trials (e.g., community trials) and the evaluation of new drug treatments;[6]

[6]One respondent felt the advent of community trials was a negative consequence of AIDS/HIV research. He indicated that there has been a "sanctioning of uncontrolled and unsophisticated trials for drug efficacy."

Table 7--Contribution of AIDS and HIV Research to Advances in the Applied Medical Sciences, Epidemiology, and Public Health and Health Services Research

Field	Respondents' expertise[a]					Contribution of AIDS/HIV research[a] according to all respondents					Contribution of AIDS/HIV research according to experts[b] in field				
		Percent					Percent					Percent			
	Number	No opinion	Little to none	Somewhat	Very much	Number	No opinion	Little to none	Somewhat	Very much	umbe	No opinion	Little to none	Somewhat	Very much
Applied medical Sciences															
Diagnostics	109	10.1	44.0	26.6	19.3	109	22.9	14.7	22.9	39.4	50	0.0	10.0	30.0	60.0
Drug development	109	9.2	57.8	16.5	16.5	110	17.3	12.7	11.8	58.2	36	0.0	8.3	11.1	80.6
Other therapeutics	84	14.3	56.0	20.2	9.5	90	40.0	18.9	6.7	34.4	25	8.0	28.0	4.0	60.0
Vaccine development	112	10.7	57.1	14.3	17.9	113	15.9	14.2	22.1	47.8	36	0.0	5.6	19.4	75.0
Epidemiology															
Biostatistics	104	11.5	50.0	23.	5.4	110	27.3	26.4	13.6	32.7	39	5.	35.9	12.8	46.2
Clinical trial development	109	10.1	41.3	22.0	26.6	111	17.1	18.9	19.8	44.1	53	1.9	17.0	15.1	66.0
Disease surveillance	106	8.5	54.7	17.0	19.8	108	14.8	10.2	21.3	53.7	39	0.0	7.7	12.8	79.5
Natural history of disease	107	9.3	43.0	22.4	25.2	1	19.8	9.0	11.7	59.5	5	0.0	9.8	9.8	80.4
Public Health and Health Services Research															
Health behavior change	110	6.4	42.7	30.9	20.0	11	0.8	14.4	21.6	53.2	56	0.0	10.7	28.6	60.7
Health care financing	04	5.8	36.5	32.7	25.0	06	20.8	23.6	20.8	34.9	58	1.7	27.6	20.7	50.0
Health care organization and delivery	109	6.4	34.9	21.1	37.6	109	18.3	29.4	21.1	31.2	62	1.6	33.9	24.2	40.3
Health education	112	7.1	30.4	26.8	35.7	111	11.7	12.6	31.5	44.1	68	0.0	13.2	27.9	58.8
Sexually transmitted disease	110	6.4	46.4	30.0	17.3	112	10.7	3.6	17.0	68.8	52	0.0	5.8	11.5	82.7
Sociology/ anthropology	103	13.6	59.2	14.6	12.6	103	31.1	22.3	19.4	27.2	28	0.0	28.6	25.0	46.4
Substance abuse	107	7.5	60.7	15.0	16.8	110	13.6	20.0	20.9	45.5	34	0.0	8.8	32.4	58.8

[a]Respondents were asked to rate their expertise and contributions of AIDS/HIV research on a 10 point scale with 1 ind cating none at al and 10 indicating very much. This table groups responses from 1 to 4 into "little to none," 5 and 6 into "somewhat," and 7 to 10 as "very much."
[b]Experts were those reporting "somewhat" to "very much" expertise (i.e., a rating of 5 to 10).

SOURCE: Off ce of Technology Assessment, 990.

- Improved methods for evaluating health risks and studying unique populations and risk groups;
- Improved disease surveillance methods and disease reporting; and
- Improved understanding of behaviors that put people at risk for disease.

Public Health and Health Services Research

The fields of sexually transmitted disease, health behavior change, health education, and substance abuse were cited as having benefited substantially from AIDS/HIV research by more than one-half of experts in these areas (table 7). The category of health care organization and delivery was cited most often as having benefited the least from AIDS/HIV research.

Specific example of contributions of AIDS/HIV research to public health and health services research included:

Health Behavior Change

- Stimulated research on the relationship between lifestyle changes, such as alcohol/drug abuse, and high-risk health behaviors;
- Stimulated research into the relationship among knowledge, attitudes, and health practices. Has provided confirmation that increased knowledge of disease and prevention leads to changes in risk behaviors among some risk groups;
- Increased understanding of safe sex practices; and
- Provided prototype programs for targeting health education to high-risk populations.

Health Care Financing

- AIDS/HIV has illustrated the financial ramifications of catastrophic illness and problems in health care financing (e.g., gaps in Medicare/Medicaid funding);
- AIDS/HIV has focused attention on the cost of drugs and drug development; and
- AIDS/HIV has raised issues regarding reimbursement for experimental therapies.

Health Care Organization and Delivery

- Stimulated research on community-based models of care (e.g., home care, hospice care, case management, community supports);
- Stimulated research on long-term care issues; and
- Has focused attention on primary prevention (e.g., research on prevention of substance abuse) and early intervention and treatment.

Health Education

- Stimulated research on the effectiveness of health education in preventing high-risk behaviors and disease;
- Facilitated public understanding of communicable disease and infection control (e.g., sexually transmitted disease);
- Has provided clear connection between lifestyle practices and disease; and
- Stimulated research into the design and conduct of health education programs (e.g., use of television and mail health education campaigns).

Sexually-Transmitted Disease

- Clarified routes and mechanisms of sexually transmitted disease (STDs);
- Facilitated an understanding of other STDs (e.g., herpes, chlamydia) and the role of co-infection;
- Improved knowledge of sexual behavior, especially within groups at high risk of STDs; and
- Lessons regarding the control of AIDS/HIV are broadly applicable to control of other STDs.[7]

Sociology/Anthropology

- Improved understanding of social stigma and prejudice;
- Revealed our lack of knowledge of sexual attitudes and customs; and
- Furthered understanding of risk-taking behaviors, social organizatin, and decision-making processes.

Substance Abuse

- Improved understanding of behavioral patterns and modification;
- Improved understanding of factors leading to substance abuse, patterns of illicit drug use, and the "drug culture;" and
- Provided insights into the effectiveness of drug treatment programs.

[7]One respondent reported that AIDS/HIV has led to the gross compromise of principles for the control of communicable disease.

Opinions Regarding Federal Spending for AIDS/HIV Research

Current Level of Federal Funding for AIDS/HIV Research-Nearly one-half of survey respondents felt that the current level of federally funded AIDS/HIV research was about right. A greater proportion of respondents felt that funding was too low (31 percent), rather than too high (18 percent) (figure 3).8 ***Scientists with*** some professional activity related to AIDS/HIV were more likely to perceive AIDS/HIV funding as too low or about right than those not engaged in AIDS/HIV activities (table 8).9

8Five percent expressed no opinion regarding federal spending on AIDS/HIV research.

9The difference in opinion on AIDS/HIV funding by professional activity related to AIDS/HIV was statistically significant as determined by the chi-square test (p=.01).

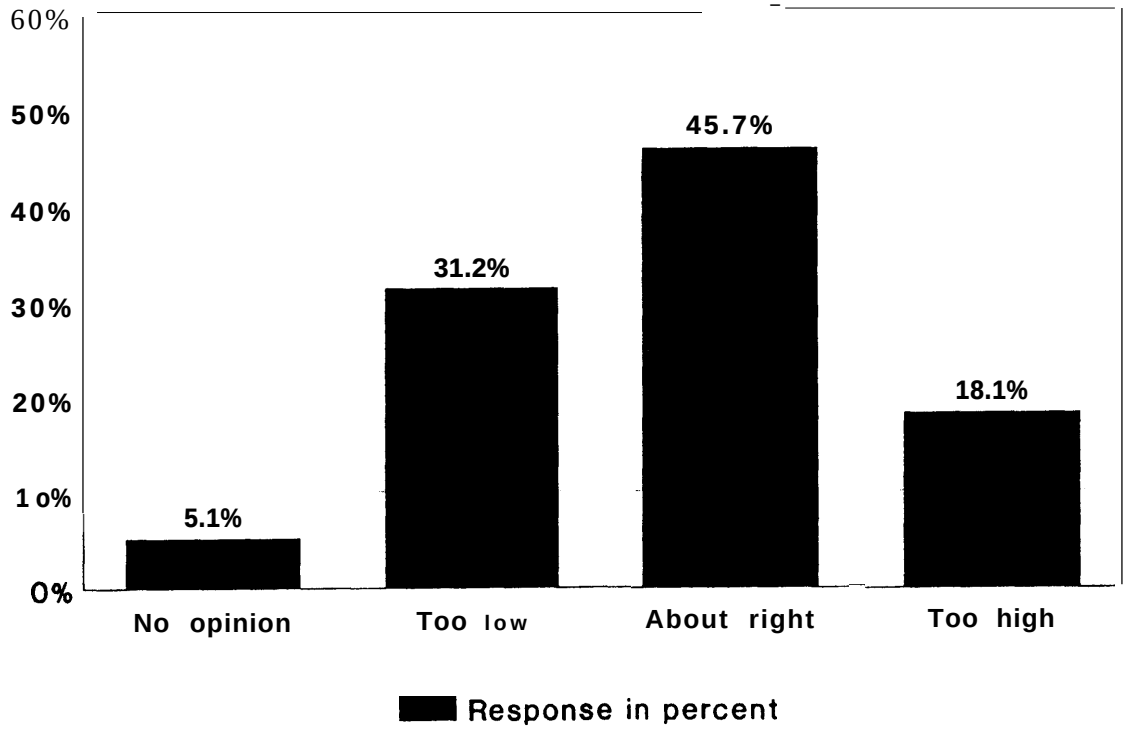
Table 8--OTA **Survey Respondents' Opinions About the Level of Federally Funded AIDS/HIV Research by Whether They Are Engaged in AIDS/HIV Professional Activities**[a]

Opinion about level of Federal AIDS/HIV funding	Professional activities related to AIDS/HIV (n=49)	(n=87)
Too low	26.5%	33.3%
About right	34.7	51.7
Too high	32.7	10.3
No opinion	6.1	4.6

[a]These differences in opinion are statistically significant as determined by the chi-square test (p=.01).

SOURCE: Office of Technology Assessment, 1990.

Figure **3--OTA Survey Respondents' Opinion About Level of Federally Funded AIDS/HIV Research (n=138)**



SOURCE: Office of Technology Assessment, 1990.

Statistically significant differences in opinion about levels of Federal funding for AIDS/HIV research are evident according to whether respondents received external funding in 1989, and whether that funding was from the Federal Government for AIDS/HIV research. Of the respondents that received no external funding, more than one-half felt that Federal AIDS/HIV funding was about right, and nearly one-third indicated that it was too low. Of those who received Federal funds for AIDS/HIV research, one-half felt that funding levels were too low, and the other one-half felt that funding was about right. By contrast, 38 percent of respondents who had received external funding for ***non***-AIDS/HIV research felt that AIDS/HIV funding was too high (table 9).

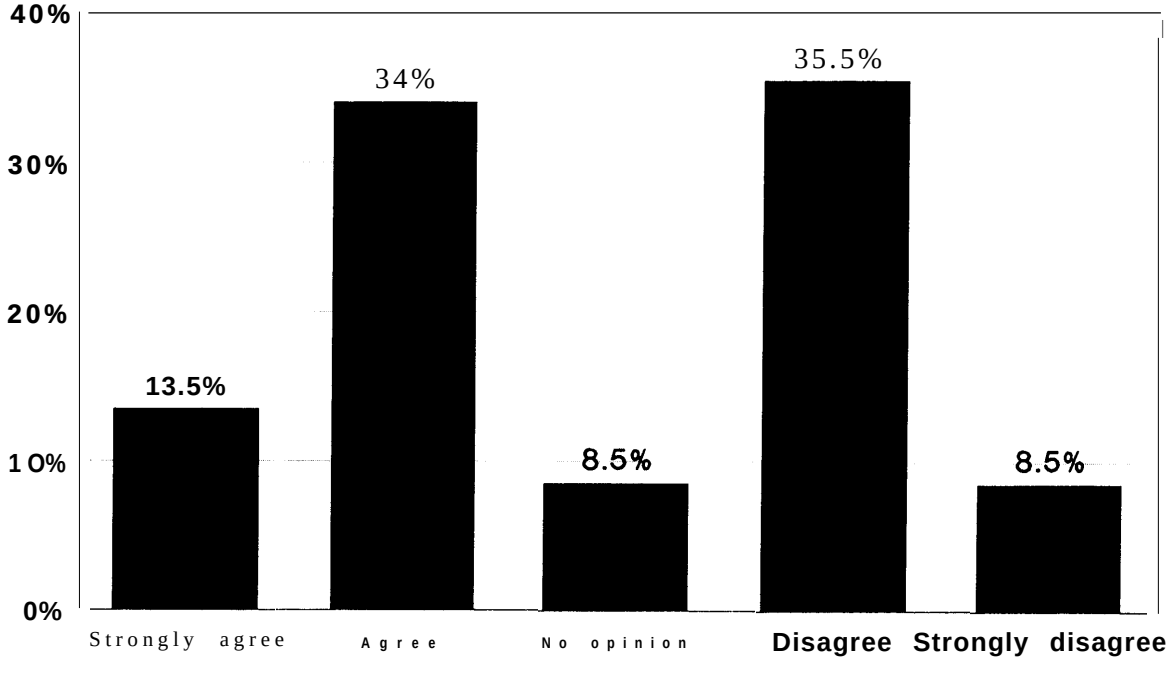
Table 9--OTA Survey Respondents' Opinions About the Level of Federally Funded AIDS/HIV Research by Whether They Receive External Funding or Federal Funds for AIDS/HIV Research[a]

		External funding	
Opinion about level of Federal AIDS/HIV funding	No external funding (n=62)	For non-AIDS/ HIV research (n=48)	For AIDS/HIV Federally funded research (n=24)
Too low 32.3%		22.9%	50.070
About right 51.6		35.4	50.0
Too high 8.1		37.5	0.0
No opinion 8.1		4.2	0.0

[a]These differences in opinion are statistically significant as determined by the chi-square test ($p < .01$).

SOURCE: Office of Technology Assessment, 1990.

Figure 4--OTA Survey Respondents' Agreement with the Statement:
"Too much research funding has been diverted toAIDS/HIV research from other fields"
(n=141)



SOUCE: Office of Technology Assessment, 1990.

Diversion of Research Funds to AIDS/HIV From Other Fields

Nearly half (48 percent) of all survey respondents agreed or strongly agreed that "Too much research funding has been diverted to AIDS/HIV research from other fields." A nearly equal proportion (44 percent) disagreed or strongly disagreed with this statement (figure 4).[10] Respondents engaged in some AIDS/HIV professional activities are less likely to feel that too much research funding has been diverted than those without such activities, but these differences are not statistically significant (table 10).

There were statistically significant differences in opinion about diversion of research funds according to whether respondents received external funding in 1989, and whether that funding was from the Federal Government for AIDS/HIV research. Thirty percent of scientists that received no external funding in 1989 agreed or strongly agreed that too much research funding had been diverted to AIDS/HIV research from other fields. Scientists receiving external funds for ***non*** AIDS/HIV research were more than twice as likely to feel that research funds had been diverted. More than one-third (38 percent) of scientists receiving Federal AIDS/HIV funds felt that too much research funding had been diverted to AIDS/HIV, but 58 percent disagreed or strongly disagreed that funds had been diverted (table 11).

10Almost all (% percent) respondents who felt that Federal funding for AIDS/HIV research is too high agreed that "too much research funding has been diverted to AIDS/HIV research from other fields," Slightly more than two-thirds (65 percent) of those who felt that Federal funding for AIDS/HIV research is too low disagreed, but 30 percent agreed that too much funds had been diverted from other fields. Among those indicating that Federal AIDS/HIV research funding is about right, 44 percent agreed and 49 percent disagreed that too much diversion had occurred.

Table IO-OTA Survey Respondents' Extent of Agreement/Disagreement with the Statement, "Too Much Research Funding Has Been Diverted to AIDS/HIV From Other Fields," by Respondents' Involvement in AIDS/HIV Professional Activities[a]

Extent of agreement with statement	Respondents' professional involvement in AIDS/HIV activities	
	(n=49)	Yes (n=90)
Strongly Agree	20.4%	10.0%
Agree	34.7	32.2
No opinion	10.2	7.8
Disagree	26.5	41.1
Strongly disagree	8.2	8.9

[a]These differences in opinion are not statistically significant as determined by the chi-square test (p= .32).

SOURCE: Office of Technology Assessment, 1990.

Table 1 l--OTA Survey Respondents' Extent of Agreement/Disagreement with the Statement, "Too Much Research Funding Has Been Diverted to AIDS/HIV From Other Fields," by Whether They Receive External Funding or Federal Funds for AIDS/HIV Research[a]

Extent of agreement with statement	No external funding (n=64)	External funding	
		Non-Federally funded and non-AIDS/HIV research (n=49)	AIDS/HIV Federally funded research (n=24)
Strongly agree	6.3%	30.6%	0.0%
Agree	23.4	42.9	37.5
No opinion	14.1	4.1	4.2
Disagree	46.9	14.3	50.0
Strongly disagree	9.4	8.2	8.3

[a]These differences in opinion are statistically significant as determined by the chi-square test (p< .01).

SOURCE: Office of Technology Assessment, 1990.

The respondents to OTA's survey indicated that significant benefits from AIDS/HIV research have flowed to a wide variety of fields ranging from the basic sciences to clinical applications and public health. More than one-quarter of respondents, for example, reported that AIDS/HIV research has contributed greatly to advances in all of the basic sciences and half of the medical disciplines included on the survey. These findings are especially noteworthy given that, as one respondent commented, substantial lead time is needed for advances to influence other fields.

Although OTA employed a survey of biomedical and social scientists to learn of contributions of AIDS/HIV research to other fields, methods other than surveys may be used to evaluate the usefulness of research. For example, bibliometric methods can examine the extent to which certain publications are used by others, and economic evaluations can assess the returns to investment in research.

Bibliometric methods have been successfully used to measure how the publications of a particular researcher or a research institute are utilized.[1] The research discipline of bibliometrics evaluates scientific publications as a measure of research output and relies on the existence of large databases containing key information on the published literature. One bibliographic method that could be used to investigate the contributions of AIDS/HIV research to other fields involves identifying a set of articles representing federally funded research in the National Library of Medicine's literature database MEDLINE (or AIDSLINE) and examining to what extent the non-AIDS/HIV literature cite these articles by using the Institute for Scientific Information's database of articles and their references (the Science and Social Science Citation Indexes (SCI and SSCI)).[2,3]

Economic analyses have been used to measure the "spinoffs" and "spillovers" of research conducted by some Federal agencies. For example, the overall benefits to society from four technologies stimulated by work at the National Aeronautics and Space Administration (NASA) --gas turbine engines, integrated circuits, cryogenics, and an advanced computer program dealing with structural analysis--were estimated to be about $7 billion over a 10-year period **(12).**[4] Another approach used to evaluate NASA spinoffs is to study how industry uses the licenses and patent waivers granted by NASA. Some benefits of federally funded research are difficult to measure. The creation of a multibillion dollar satellite communications industry and a tenfold reduction in the cost of satellite communications, for example, can be traced to NASA's space research and development program (12).

Because substantial Federal funding for HIV research is relatively recent, dating only from the latter part of the 1980s, it would be premature to evaluate the economic implications of its applications in other fields. Even in the best of circumstances, one would expect several years to elapse from the start of research on HIV to applications to HIV disease and an even longer lag for advances from HIV research to be incorporated into other fields and produce tangible economic benefits.

1Bibliometric methods have also been used to study researcher productivity, the evolution of scientific fields, the diffusion of scientific ideas, program evaluation, and the identification of innovative areas of scientific research (4,5,8,10,11).

2Another approach would involve identifying a set of highly-cited AIDS/HIV research articles within SCI and seeing to what extent these articles are cited by non-AIDS/HIV articles within both SCI and SSCI.

3The principal difficulty in conducting these analyses is distinguishing the AIDS/HIV literature from the non-AIDS/HIV literature. Any bibliometric analysis would require retrieving articles or their abstracts and reviewing them for content.

4The analysis was conducted in 1975 for the period 1975 to 1984. Economic benefits were measured in constant 1975 dollars (12).

Two studies exemplify approaches to address underlying issues related to funding for HIV research, namely the appropriateness of the distribution of resources between HIV and other research areas and the distribution of HIV research funding among different categories.

Using funding levels for fiscal year 1986, Hatziandreu and her colleagues compared Federal spending for biomedical research that was targeted to HIV disease with spending for other leading causes of death in the United States (2). Based on expected deaths and potential years of life lost for 1991, they calculated research expenditures per unit of disease burden for several conditions. They concluded that AIDS was receiving about the same priority as cancer and that there was no indication that funding for AIDS was excessive relative to cancer and heart disease. Compared with 1986, however, funding for HIV research has increased about fourfold. Comparable figures are not available for current Federal funding of research on cancer and heart disease.

To examine the allocation of funds for HIV research among alternative uses, Siegel and her colleagues surveyed members of the Institute of Medicine's Committee on AIDS, a multidisciplinary group that had studied Federal HIV policy (9). Compared with the distribution contained in the expected budget for fiscal year 1987, the dominant sentiment of these experts favored increased funding for research on behavioral and social science.

The findings of OTA's survey also address the issue of allocating resources among different research areas. Although over three-quarters of the respondents felt that Federal spending for AIDS/HIV research was about right or too low, nearly half felt that too much of available research funds has been diverted to AIDS/HIV research from other fields. These responses indicate not only support for current or augmented Federal AIDS/HIV research funding levels but also concern that other research areas are not adequately funded.

Not surprisingly, responses to questions about the level of Federal spending for AIDS/HIV research depend on whether scientists are engaged in AIDS/HIV research and whether they depend on Federal resources. Scientists in receipt of Federal funds for AIDS/HIV research are most likely to hold the opinion that Federal AIDS/HIV funding is too low, and more than two-thirds of scientists receiving external finding for other-than AIDS/HIV research felt that too much research funding has been diverted to AIDS/HIV from other areas.

Nearly one-half of OTA survey respondents received no external funding in 1989. The opinions expressed by these respondents are of particular interest because they are less likely to have vested interests in funding policies. Over one-half of these respondents felt that AIDS/HIV funding is about right, and nearly one-third felt that funding was too low. Only eight percent felt that AIDS/HIV funding was too high. On the question of diversion of research funds, more than one-half of scientists without external funding did not agree, but nearly one-third agreed that too much research funding has been diverted to AIDS from other areas. Over one-half of scientists who receive Federal support for AIDS/HIV research disagreed that research funds have been diverted to AIDS from other areas, but as many as 38 percent agreed that diversion has occurred.

In addition, in separate comments, survey respondents raised the issue of allocating resources to HIV and other targeted fields versus to basic research. One respondent, for example, pointed out that contributions from basic research conducted prior to the HIV epidemic had furthered advances in subsequent HIV research and, while questioning the contributions of HIV research to basic biology, felt that, "...our understanding of basic biology has made possible all AIDS research."

In conclusion, results from OTA's survey indicate that, in the opinion of the scientific community, HIV research has made many important contributions to advances in the biomedical and behavioral sciences. Furthermore, the dominant sentiment of survey respondents support current or augmented levels of HIV research. Opinion was divided on the question of whether too much research funding has been diverted to AIDS/HIV research from other fields. The results raise for continued consideration the appropriate allocation of research funds among HIV, other targeted areas, and basic science.

References

1. Booth, W., "No Longer Ignored, AIDS Funds Just Keep Growing," ***Science 242(4880):858-859, Nov.*** 11,1988.
2. Hatziandreu, E., Graham, J.D., and Stoto, M.A., "AIDS and Biomedical Research Funding: Comparative Analysis," ***Reviews of Infectious Diseases 10(1):159-167,*** Jan.- Feb. 1988.
3. Lucchesi, J. C., "NIH Budget Crisis," (letter) ***Science :393,*** January 1990.
4. Narin, F., "Bibliometric Techniques in the Evaluation of Research Programs," ***Science and Public Policy 14(2):99-106,*** April 1987.
5. Narin, F., ***Concordance Between Subjective and Bibliometric Indicaton of the Nature and Quality of Performed Biomedical Research,*** A Program Evaluation Report for the Office of Program Planning and Evaluation, National Institutes of Health, Public Health Service, U.S. Department of Health and Human Services, April 1983.
6. Palca, J., "Hard Times at NIH," ***Science 246(4933):988-990,*** Nov. ***24,1989.***
7. Rogers, D.E., "Federal Spending on AIDS--How Much Is Enough ?," New ***Engl. J. Med. 320(24):1623-1624,*** June 15, 1989.
8. Self, P. C., Filardo, T. W., Lancaster, F. W., "Acquired Immunodeficiency Syndrome (AIDS) and the Epidemic Growth of its Literature," ***Scientometrics 17(1-2):49-60, 1989.***
9. ***Siegel,*** J. E., Graham, J. D., and Stoto, M.A., "Allocating Resources Among AIDS Research Strategies," ***Policy Sciences 23(1):1-23,*** 1990.
10. Small, H. and Greenlee, E., "A Co-Citation Study of AIDS Research," ***Communication Research 16(5):642-666,*** October 1989.
11. Small, H. and Pendlebury, D., "Federal Support of Leading-Edge Research: Report on a Method for Identifying Innovative Areas of Scientific Research and Their Extent of Federal Support," U.S. Congress, Office of Technology Assessment Contract Paper J3-4879.0, February 1989.
12. U.S. Congress, Office of Technology Assessment, ***Research Funding as an Investment: Can We Measure the Returns?*** OTA-TM-SET-36 (Washington, DC: U.S. Government Printing Office, April 1986).
13. U.S. Department of Health and Human Services, Public Health Service, Budget Office, unpublished data, Washington, DC, Feb. 28, 1990.
14. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, "Years of Potential Life Lost Before Ages 65 and 85--United States, 1987 and 1988," ***Morbidity and Mortality Weekly Report 39(2);20-21,*** Jan. 19, 1990
15. U.S. Executive Office of the President, Office of Management and Budget, ***Budget of the United States Government - Fiscal Year 1991*** (Washington, DC: U.S. Government Printing Office, 1990).
16. Winkenwerder, W., Kessler, A. R., and Stolec, R. M., "Federal Spending for Illness Caused by the Human Immunodeficiency Virus," New ***Engl. J. Med.*** **320(24):1598-1603,** June 15,1989.

Appendix A
Method of the Study

OTA staff designed a survey instrument to examine whether AIDS and HIV research has contributed to advances in other biomedical and social science fields. Six people with varying degrees of familiarity with AIDS/HIV research reviewed the questionnaire and accompanying cover letter. Based on their comments, OTA staff revised both the questionnaire and the cover letter (see app. B for final questionnaire and cover letter).

In February 1990, OTA mailed packets including a questionnaire, a cover letter, and an addressed return envelope to 400 people. The recipients were randomly selected from a membership list of an organization of distinguished biomedical and social scientists. The packets differed by type of mail delivery and type of cover letter. Two hundred were sent by overnight mail, accompanied by a personalized cover letter (Group A); 100 were sent by first class mail with a personalized cover letter (Group B); and 100 were sent by first class mail with a "Dear Colleague" letter (Group C). The response rates were 44.5 percent for Group A, 32 percent for Group B, and 26 percent for Group C.[1] Overnight mail and personalized cover letter thus increased the response rates.

The questionnaire solicited comments on 42 different fields that comprised 5 broad areas: basic science, medical disciplines, applied medical sciences, epidemiology, and public health and health services research. The recipient was asked to rate, on a scale of 1 to 10, the contributions that AIDS/HIV research had made to each field and the recipient's expertise in each field. The main text of this document reports the results of this portion of the survey. The recipients were also asked to give specific examples of contributions of AIDS/HIV research to each specific field. Appendix E lists the responses to this portion of the survey. These responses include those received during the pilot test of the questionnaire. Recipients were also asked questions about AIDS/HIV funding levels and general demographic information. The main text also reports the results of this portion of the survey. Respondents' primary fields of expertise are listed in Appendix D.

Seven returned questionnaires included indications that the randomly selected recipient was not the sole respondent. Six of the **7** questionnaires indicated that the respondent was someone other than the randomly selected recipient. These responses were not included. One questionnaire indicated that the randomly selected recipient and another person had jointly filled out the questionnaire. This questionnaire included demographic characteristics for both people. Only the demographic characteristics of the randomly selected respondent were included; all other responses were included.

In late February 1990, a draft Staff Paper was prepared and sent to outside reviewers for comment. These reviewers came from a range of relevant fields including HIV biomedical research, non-HIV biomedical research, public health, medicine, health care organization and delivery, health education and behavior, and consumer advocacy. Based on their comments, the Staff Paper was revised in March 1990.

1Only completed or partially completed questionnaires were included in calculating the response rate. If returned blank questionnaires are included, the response rates are 57 percent, 40 percent, and 32 percent for groups A, B, and C, respectively.

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Congress of the United States
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, DC 20510–8025

January 31, 1990

Dear Colleague:

The Congressional Office of Technology Assessment (OTA) is conducting a survey to learn more about contributions that research funded by the federal government on Acquired Immunodeficiency Syndrome (AIDS) and the Human Immunodeficiency Virus (HIV) may have made to advances in other fields. Findings from the survey will form the basis of an OTA Staff Paper that has been requested by the Subcommittee on Human Resources and Intergovernmental Relations, House Committee on Government Operations.

You are one of a group of distinguished biomedical and social scientists who have been selected to receive the survey. Please complete this form and return it to OTA in the enclosed envelope by February 12.

Your responses are, of course, confidential and anonymous. The data gathered will be presented only in aggregate form.

We appreciate very much your participation in the survey. Only by gathering data from knowledgeable people can we provide Congressional committees with the accurate, reliable information that they need.

If you have any questions or prefer to respond by telephone, please contact either Dr. Maria Hewitt or me in the Health Program by phone at 202/228-6590 or by FAX at **202/228-6098.**

Sincerely,

Jane E. Sisk, Ph.D.
Senior Associate

OFFICE OF TECHNOLOGY ASSESSMENT, U.S. CONGRESS

SURVEY ON CONTRIBUTION OF RESEARCH ON AIDS AND HIV TO OTHER FIELDS

1. Use the scale below to indicate to what extent you think federally-funded AIDS/HIV research has contributed to advances in the fields listed. Use the same scale to indicate how expert you feel in each field, Please cite specific examples of contributions in each field with which you are familiar. If you wish, attach additional sheets for all or part of your response.

RATING SCALE: Very much 10 ----- 9 ----- 8 ----- 7 ----- 6 ----- 5 ----- 4 ----- 3 ----- 2 ----- None at all 1

FIELDS	RATINGS: CONTRIBUTION OF AIDS/HIV RESEARCH	RATINGS: YOUR EXPERTISE IN EACH FIELD	SPECIFIC EXAMPLES
BASIC SCIENCES			(e.g., *identification of regulatory genes and* their *functioning)*
Biochemistry	____	____	
Cell biology	____	____	
Genetics	____	____	
Immunology	____	____	
Microbiology	____	____	
Molecular biology	____	____	
Pathology	____	____	

RATING SCALE: Very much 10 ----- 9 ----- 8 ----- 7 ----- 6 ----- 5 ----- 4 ----- 3 ----- 2 ----- None at all 1

FIELDS	RATINGS: CONTRIBUTION OF AIDS/HIV RESEARCH	RATINGS: YOUR EXPERTISE IN EACH FIELD	SPECIFIC EXAMPLES
Pharmacology	____	____	
Virology	____	____	
Other (please specify) _____	____	____	
MEDICAL DISCIPLINES			*(e.g., for Oncology: application of insights about regulatory genes to malignant changes)*
Cardiology	____	____	
Dentistry	____	____	
Dermatology	____	____	
Endocrinology	____	____	
Gastroenterology	____	____	
Hematology	____	____	

RATING SCALE: Very much 10 ----- 9 ----- 8 ----- 7 ----- Somewhat 6 ----- 5 ----- 4 ----- 3 ----- 2 ----- None at all 1

FIELDS	RATINGS: CONTRIBUTION OF AIDS/HIV RESEARCH	RATINGS: YOUR EXPERTISE IN EACH FIELD	SPECIFIC EXAMPLES
Infectious disease	____	____	
Nephrology	____	____	
Neurology	____	____	
Obstetrics/ gynecology		____	
Oncology		____	
Ophthalmology	____	____	
Pathology	____	____	
Pediatrics	____	____	
Psychiatry	____	____	

RATING SCALE: Very much 10 ----- 9 ----- 8 ----- 7 ---- 6 ----- 5 ----- 4 ----- 3 ----- 2 ----- Somewhat 1 None at all

FIELDS	RATINGS: CONTRIBUTION OF AIDS/HIV RESEARCH	RATINGS: YOUR EXPERTISE IN EACH FIELD	SPECIFIC EXAMPLES
Pulmonary medicine			
Rheumatology			
APPLIED MEDICAL SCIENCES			***(e.g., for Therapeutics: anti-viral therapy for other illnesses)***
Diagnostics			
Drug development			
Other therapeutics			
Vaccine development			
Other (please specify) _____			

RATING SCALE: **Very much** 10 ----- 9 ----- 8 ----- 7 ----- **Somewhat** 6 ----- 5 ----- 4 ----- 3 ----- 2 ----- **None** at all 1

FIELDS	RATINGS: CONTRIBUTION OF AIDS/HIV RESEARCH	RATINGS: YOUR EXPERTISE IN EACH FIELD	SPECIFIC EXAMPLES
EPIDEMIOLOGY			*(e.g., for* Clinical *trials: community-based trials)*
Clinical trial development	____	____	
Disease surveillance	____	____	
Natural history of disease	____	____	
Other (please specify) _____	____	____	
PUBLIC HEALTH AND HEALTH SERVICES RESEARCH			*(e.g., for Health Education: providing death education to substance abusers)*
Health care financing	____	____	
Health care organization and delivery	____	____	

RATING SCALE: Very much 10 ----- 9 ----- 8 ----- 7 ----- Somewhat 6 ----- 5 ----- 4 ----- 3 ----- 2 ----- None at all 1

FIELDS	RATINGS: CONTRIBUTION OF AIDS/HIV RESEARCH	RATINGS: YOUR EXPERTISE IN EACH FIELD	SPECIFIC EXAMPLES
Health education and behavior change	____	____	
Sexually transmitted disease	____	____	
Substance abuse	____	____	
Other (please specify) _____	____	____	
OTHER (PLEASE SPECIFY)			
_____	____	____	
_____	____	____	
_____	____	____	

2. Indicate your general opinion about the level of federally-funded AIDS/HIV research. The current level of funding is:

____ too low ____ about right ____ too high ____ no opinion

3. To what extent do you agree or disagree with the following statement: "Too much research funding has been diverted to AIDS/HIV research from other fields?

_____ _____ _____ _____ _____

strongly agree agree no opinion disagree strongly disagree

4. What is your primary field of expertise? (if more than one, indicate which is paramount)

_____

5. What is your highest level of training?

____ MD
____ PhD
____ Other (please specify _____

6. What is your major activity?

Research
____ Patient care
____ Education
____ Administration
____ Other (please specify) _____

7. By whom are you primarily employed?

____Federal or state government
____Non-profit organization, including university
____Private business
____Other (please specify) _____

8. Please indicate your age category:

____ age 35 and younger ____ age 36-50 ____ age 51-65 ____ age 66 and older

9. What proportion of your professional activies relate to AIDS/HIV?
____ percent

10 Did you receive any external funding in 1989?

____ Yes
____ No
____ Does not apply

If yes,

what percentage came from the federal government?
____ percent

what percentage was for AIDS/HIV research?
____ percent

what percentage was for federally-funded AIDS/HIV research?
____ percent

Thank you very much for completing the survey. If you would like any further information, please contact Dr. Jane Sisk or Dr. Maria Hewitt at the Office of Technology Assessment 202/228-6590. Please return the completed survey by February 12 in the enclosed envelope to:

Jane E. Sisk, Ph.D.
Senior Associate
Office of Technology Assessment
U.S. Congress
Washington, DC 20510-8025

Appendix C
Acknowledgements

This project has benefited from the advice and the review of a number of people. OTA staff would like to express its appreciation to the following people for their valuable guidance.

Marshall Becker, Ph.D., M.P.H.
School of Public Health
The University of Michigan
Ann Arbor, MI

Anthony Fauci, M.D.
National Institute of Allergy
and Infectious Diseases
National Institutes Health
Bethesda. MD

Margaret Hamburg M.D.
National Institute of Allergy
and Infectious Diseases
National Institutes of Health
Bethesda, MD

Austin R. Kessler, M.B.A.
Office of Assistant Secretary
for Planning and Evaluation,
Health Planning
U.S. Department of Health
and Human Services
Washington, DC

David Kern, M.D.
School of Medicine
Stanford University
Stanford, CA

Jeffrey Levi, M.A.
Gay Men's Health Crisis
Washington, DC

Lincoln E. Moses, Ph.D.
Statistics Department
Stanford University
Stanford, CA

Gary Noble, M.D.
HIV/AIDS Programs
Centers for Disease Control
Atlanta, GA

June E. Osborn, M.D.
School of Public Health
The University of Michigan
Ann Arbor, MI

Michael Rosenblatt, M.D.
Merck, Sharpe, & Dohme
Research Laboratories
Merck & Co., Inc.
West Point, PA

Henry Small, Ph.D.
Institute for Scientific
Information
Philadelphia, PA

Appendix D

OTA Survey Respondents' Primary Field of Expertise[a]

Field	Frequency
BASIC SCIENCES	
Biochemistry	5
Bioengineering	2
Cell biology	2
Developmental biology	1
Genetics	4
Immunology	2
Microbiology	2
Molecular biology	2
Neuroscience	3
Physiology	2
Virology	2
Total	27
MEDICINE	
Anesthesiology	1
Cardiology	5
Endocrinology	1
Family practice	4
Gastroenterology	1
Hematology	1
Infectious disease	9
Internal medicine	13
Neurology	3
Obstetrics/gynecology	1
Occupational medicine	2
Oncology	5
Oral medicine	4
Pathology	2
Pediatrics	7
Psychiatry	3
Radiology/nuclear medicine	3
Rheumatology	2
Surgery	1
Toxicology	1
Medicine, unspecified specialty	3
Total	72

SURVEY RESPONDENTS'-continued

Field	Frequency
EPIDEMIOLOGY	*4*
PUBLIC HEALTH AND HEALTH SERVICES RESEARCH	
Health care administration	*4*
Health care financing	1
Health education	1
Health services research	*2*
Public health, health policy	*7*
Total	15
OTHER	
Aging	3
Economics	*4*
Nursing	*3*
Psychology	*2*
Public administration	1
Sociology	3
Total	16
UNSPECIFIED	13
TOTAL	*147*

[a]Respondents' were asked to report their primary field of expertise in an open-ended format on the questionnaire.

Appendix E

Specific Examples of Contributions of AIDS/HIV Research to Other Fields

Number of responses	Specific examples (listed by area and field)
179	**BASIC SCIENCES**
21	**Biochemistry**
2	Biochemistry of polymerase protease, transcriptional activation and regression, all applicable to different biological systems
1	Glycoprotein and gene product characterization
1	Identification of regulatory genes, their function, and role in latency
1	Mechanism of ribonucleic acid (RNA) synthesis control
1	Control of transcription and translation
1	Protein processing
1	Gene organization
2	Protein structure/enzyme of human immunodeficiency virus (HIV) (e.g., reverse transcriptase)
2	Crystal structure of proteins; design of substrate inhibitor
1	Studies of aspartic protease and thein inhibition
1	Novel understanding of protein-deoxyribonucleic acid (DNA) or RNA interactions
1	Structure/function studies of inhibitors of reverse transcriptase and viral protease
1	Binding of protein to DNA
1	Interaction of envelope proteins with cellular CD-4 receptors
1	Viral coded enzymes and their expression
1	Identified functional domains and mechanism of DNA polymerase
1	Progress in the “anti-sense” approach to treatment of viral disease and cancer
1	Isolation of regulatory c-effecter and viral proteins

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
22	**Cell Biology**
1	**Regulatory Genes**
3	**Cell transport, protein processing interaction by cytokines, autocrin pathways, cell activation**
2	**Cell receptor interactions leading to normal function, abnormal function and cell death**
1	**Identification of cell lines allowing replication**
1	**Role of cytokines as growth factors**
1	**Compartmentalization of pathologic products**
1	**Cell fusion mechanism, transection**
2	**Viral effects and cell function**
1	**New understanding of RNA splicing and regulation of nuclear-cytoplasmic transport, new understanding of regulation of transcription**
2	**Understanding of CD-4 receptor function**
1	**Mechanism of receptor/ligand endocytosis and transport to and release from lysosomes**
2	**Understanding of basic growth and development process**
1	**Mechanism of latency-- many contributions to cell biology**
1	**Viral replication, budding, and morphology**
1	**Enhanced understanding of intra and intercellular communication, (e.g., activation signals, secondary messengers)**
1	**Major impact on signal transduction, mechanism of c-effecter activation/differentiation**

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
16	**Genetics**
2	**Genetic organization and control of all retroviruses including HIV, human T-cell lymphotropic virus, (HTLV), other tumor and immunodeficiency viruses**
3	**Regulation of gene expression**
1	**Mutation rates**
2	**Relatedness of HIV and simian immunodeficiency virus**
1	**Retroviruses as vectors for gene transfer**
1	**Studies of mutation in in vivo**
1	**Mechanism of integration into host genome**
1	**Mechanism and fidelity of viral RNA reverse transcription and proviral integration**
1	**Recombination**
1	**Research on genetic factors that influence susceptibility to infection and patterns of immune dysfunction**
1	**Identification of regulatory genes and their function**
1	**Transcriptional regulation**
34	**Immunology**
1	**Understanding of retroviruses**
1	**Understanding basic pathogenesis**
1	**Stimulated research on effect of alcohol on immunological system (cellular and humoral immune responses and neurohormonal immunodulation)**
1	**Cell and antibody mediated immune recognition of antigen and prevention of infection**

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Cell mediated immune response controls susceptibility to some protozoal (Pneumocystis), fungal (Cryptococcus), and bacterial (p.multocida) infections
2	Elucidation of lymphocyte biology, subsets, networks interactions, profound insight into CD-4 lymphocyte biology and function
6	T-cell function, immunoregulation, cellular immunology in general
1	Mechanism of virus targeting and immunoresponse suppression
1	Mechanism of immune control of viruses
1	Pivotal role of CD-8 bearing T-cells in the immune process
1	Role of immune disregulation
2	Better understanding of roles of T and R lymphocytes in the immune process
1	Careful characterization of lymphokine and monokine regulation and CD-4 and adhesion molecule function
2	Enhanced understanding of interactions of cellular components and lymphokines
3	Deeper understanding of immune system and of multiplicity of diagnostic probes
1	Immunoregulation, cytokine action, immunodeficiency, animal models
1	Understanding of resistance of viruses
1	Importance of microphage as a viral reservoir
1	AIDS has essentially had a confirmatory role on aspects of cell-mediated immunity
1	Knowledge of antibodies to surface antigens operate
1	Elucidation of peptide sequences that specifically signal T-lymphocytes
1	Elucidation of immune epitopes

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Development of SCID mouse model that can be used to evaluate “human-like” immune response to a number of pathogens
1	Model for research on other immune deficiency disorders; insight into normal and immune function and regulation
20	Microbiology
1	Viral genetics
2	Elucidation of genetic complexity and biology of human and primate retroviruses
4	Insight into HIV related opportunistic infections
2	Co-pathogenesis relations to other retroviruses and to fungi
2	Served as a paradigm for the study of viral pathogenesis
1	Microbial pathogenesis
1	Mechanism of viral latency and transactivation
1	Virus growth and assay techniques
1	Methods to allow the search for potential retroviral disease causing agents
1	Better understanding of all opportunistic infectious agents
1	Applications of polymerase chain reaction (PCR) techniques to diagnosis of cancer
1	Studies of viral evolution and monitoring of viral spread through Africa and world populations
1	Field of human retrovirology has been opened
1	Expression of active enzymes in E.coli

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
15	**Molecular Biology**
3	Control of genes, reverse transcriptase mediated alteration of genomes, insertion of control elements
2	Broadly applicable principlein transcriptional activation, transcriptional and translational control mechanism, RNA processing, advances in genetic engineering
1	Regulator circuits
1	Encoding and sequence similarities
1	Excellent virus for the study of cis and trans regulation factors
1	Genetic variation, processing signals
1	Gene structure and regulation
1	Application of novel strategies (e.g., PCR)
1	Stimulated use of PCR
1	Studies of how accessory genes affect viral latency and transcription
2	Identification of HIV genes and their function and components of HIV lifecycle have implications for all other viruses
15	**Pathology**
2	Pathogenesis of viral induced immune suppression
1	New insights into AIDS dementia, other retroviral nervous system disease such as Tropical Spastic Paraparism caused by HTLV-1
5	Better understanding of the pathologies of Kaposi's sarcoma (KS) and opportunistic infections
1	New organ system relationships

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Growth of human cells (organs) in immunodeficient animals (mice) -unique experimental model
1	Improved concepts of pathological consequences of infectious agents
1	Understanding effect of virus
1	Neuropathology of central nervous system (CNS) complications
1	Microglial or microphage involvement in AIDS encephalopathy
1	Development of new techniques to isolate and culture microbes in pathology specimens
13	Pharmacology
5	Development of antiviral, antifungal and anticancer therapies/agents
3	Better understanding of antiviral drug action
1	Development of CD-4 blocking strategy
1	Protease inhibitors
1	New treatment methods, such as synthetic peptides
1	New drug design and modeling
1	Targeted drug development established for AIDS provides a model and kind of knowledge for development and testing compounds against other viruses; drugs developed against HIV may have other applications; development of animal models for chemoprevention of retroviral transmission; Development of tests for toxicity
22	Virology
1	Viral Genetics
7	Profound insight into new classes of retroviruses--human and primate, immunodeficiency

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
4	Mechanism of retrovirus replication, integration and control of RNA synthesis
2	Mechanism of persistent infection and latency
1	Detailed analysis of virus replication
2	Co-pathogenisis with other related and coexisting viruses
1	Regulation of retroviral genes by host factors (e.g., 50 kd cellular protein binds to LTR (long term repeat) of HIV-1 and regulates transcription)
1	Life cycle of RNA viruses
1	Identification of receptors, varying protein coats
1	Latency and integration of retroviruses
1	Pathophysiology of retroviruses
1	Other
1	Psychobiology- relation of specific pathology caused by HIV infection in brain to behavioral changes in victims- results will eventually have importance for other dementias (e.g., Alzheimers)
168	MEDICAL DISCIPLINES
4	Cardiology
4	Understanding mechanism of AIDS-related cardiomyopathies
8	Dentistry
1	Drastically changed dental research. Dental research has turned significantly to basic research (virology, microbiology, molecular biology, immunology) in understanding oral soft tissue and salivary gland disease; has begun to use biostatistics and epidemiology in more areas and has begun to explore behavioral and attitude studies;
4	Emphasized need for and improved infection control

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Understanding oral complications of immunosuppression
1	Study of the mechanism of thrush
1	Possible role of salivary components as antiviral agents
11	Dermatology
2	New dermatopathic illness (and descriptions of them) secondary to HIV
6	Broader understanding of nature/treatment of skin pathology in immunodeficient subjects, including KS
1	Dermal functions of immunologic system surveillance
1	Methods for in situ and PCR hybridization
1	Viral causes of skin deficiencies
6	Endocrinology
2	Helped in the development of tools to study autocron events and growth factor regulation
1	Better understanding of circulating cytokines
1	Insights into adrenal failure and AIDS-associated endocrinopathies
1	Autoimmune system
1	Understanding of neuro-endocrine pathways
5	Family Practice
1	Psycho-social-medical care of complex illness affecting mind, body and family
1	importance and methods of obtaining accurate sexual history
2	Management of AIDS in community setting
1	New focus on epidemiology within family practice research

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
9	Gastroenterology
1	New gastrointestinal (GI) illness associated with HIV
2	Better understanding of development of leukepenia, KS, and opportunistic infections of the GI tract
1	Improved understanding of Cryptosporidium
1	Mechanism of inflammatory bowel disease
1	Interaction of intestinal infections and malabsorption syndromes, nutritional deficiencies
1	How other viruses lead to intestinal pathology
2	Insights into the diagnosis and treatment of GI infections; treatment of chronic diarrheal disease
10	Hematology
1	Understanding of blood transfer in disease
1	Identification of cellular subpopulations and the function and development stages for each subtype
1	New spectrum of immunodeficiency associated cancers
1	Lymphocyte, microphage biology
1	Major stimulus to the cloning and study of colony stimulating factors
1	Role and use of colony stimulating factors
1	Improved understanding of regulation of bone marrow and mechanism of ITP
1	Stem cell renewal
1	Improved protection of the nation's blood supply

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Insight into role of wide range of blood components and related dysfunction/disease
18	Infectious Disease
1	Understanding the impact of loss of lymphocyte function and therapeutic strategies for dealing with infections in an immunocompromised host
3	New spectrum of immunodeficiency-associated infection
3	Better understanding of spectrum of opportunistic viral illness
6	Treatment of opportunistic infections, including new antiviral and antifungal
1	New understanding of multiple infectious agents, including AIDS and several opportunistic pathogens
1	New concept in the management of infectious diseases, their epidemiology, and their prevention
2	Detailed understanding of a virus
1	Understanding transmission of sexually related disease
2	Nephrology
2	New concepts in glomerulopathies
15	Neurology
1	Understanding AIDS encephalopathy
1	Better understanding of subcortical dementia
3	New spectrum of associated neurological illness, dementia, and peripheral neuropathy
1	AIDS dementia reveals alternative mechanisms of cognitive decline, indirect chemical bases, with absence of direct pathology

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
3	Better understanding of role of viruses in CNS disorders, improved recognition of viral causes of subtle disorders of mental function
1	New understanding of viral encephalopathy at mechanistic and clinical level
3	Insight into mechanisms of dementia and degenerative CNS disease, HTLV, and multiple sclerosis
1	Relevance of microphage-derived cells and possibly soluble protein factors on the function of the nervous system
1	Blood-brain-barrier affects CNS microphage and other cells' roles in infection
7	Obstetrics/gynecology
4	Improved recognition of maternal-fetal viral transmission
1	Avoidance of internal fetal monitoring and use of scalp electrodes
1	New studies of cervical neoplasias associated with immunosuppression, viral transmission during pregnancy
1	Studies of exogenous virus transplacental transmission and transmission during breastfeeding
21	Oncology
4	New understanding of Kaposi's Sarcoma (KS)
1	Understanding of viral-induced changes in cell function
1	Importance of drugs influencing, DNA structure and function
3	New spectrum of immunodeficiency-associated cancers and further information about these rare cancers
3	Mechanism of oncogenesis
2	New insight into viral etiology of neoplasm

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Knowledge of unrestrained epithelial growth that seem to underlie KS and its relationship to oncogenesis and growth factors
2	Gene control, cell proliferation, and cell regulation as they relate to the formation of malignant cells
2	Regulatory gene (tat) transected into mice, cancer symptoms of Kaposi's sarcoma tat has a direct effect on development of tumors
1	Mechanism of cell transformation
1	Defining genomes of leukemia
7	Ophthalmology
7	*New* understanding of cytomegalvirus (CMV)-retinitis (therapy with gancyclovir) will have broader applications
5	Pathology
1	Importance of viral-cell interactions in the induction of disease of all systems
2	Development of more efficient and accurate techniques for measuring presence of virus in tissues and developing diagnostic technology, (i.e., T/B lymphocytes and ratios)
1	Use of in situ hybridization to detectHIV
1	Methods for RNA detection in situ
9	Pediatrics
2	Better understanding of maternal-fetal interrelationships, cell transfer, passive immunity, and genetic basis of disease
1	New approach to medical and social care
1	Effects on understanding of pediatric immunodeficiencies (e.g., primary as well as maternal/fetal transmission of viruses)
2	Pediatric immunodeficiency and congenital viral infection

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
2	Provided insight into development of immune system in children
1	Insight into neurological development and immune function
10	Psychiatry
1	Stimulated research on HIV-related psychopathology (e.g., AIDS-related dementia)
2	Improved understanding of AIDS-related dementia (will relate to other dementias)
1	Improved understanding of intravenous (IV) drug users interaction and environment
1	Behavior modification and studies of high-risk behavior
2	Reaction to terminal illness of patients and families
1	Crisis intervention therapy
1	Studies of sexual behavior
1	New approach to substance abuse
17	Pulmonary medicine
5	New spectrum of illnesses
3	New pulmonary diagnostics for viral respiratory illness
1	Outpatient management of severe viral disease (i.e., aerosolized antiviral agents for pneumocystis)
3	Detailed understanding and improved management of Pneumocystis carinii pneumonia
2	Improved bronchoscopic techniques
3	Improved treatment of lung infections (e.g., pneumonias)

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
4	**Rheumatology**
2	**Autoimmune diseases**
1	**Immune cell function**
1	**Better understanding of rheumatoid arthritis, lupus, etc.**
54	**APPLIED MEDICAL SCIENCES**
21	**Diagnostics**
2	**Development of PCR**
1	**Virus culture**
1	**Identification of pathogen, stage of infection, types of immune response, and cellular populations**
4	**Stimulating use/development of newer diagnostic tests such as those employing PCR and RIA**
1	**Antibody, reverse transcriptase and other assays**
1	**Protection of the blood supply**
1	**Better clinical screening for PCP, KS, CMV retinitis**
2	**Development of new diagnostics**
2	**Improvement of old diagnostic techniques**
1	**Imaging advances-- GI tract, nodes, and mesentery**
1	**Rapid diagnostic serologic tests for screening**
1	**Improved techniques for measuring T and B lymphocytes**
1	**Improved anatomic pathology for diagnosis of tissue infection with viruses**
1	**Use of PCR as means of detecting extremely low levels of virus in blood**

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Improved diagnostics for HIV associated disease
17	Drug development
1	Drugs that will influence gene expression and prevent viral induced changes in human genome
1	Aerosolizes pentamidine for pneumocyctis
1	Drugs to inhibit viral replication
10	New antiviral, antiparasitic, antibiotic behavior therapy
1	Expedited approval use of medication
1	Initiation of search for protease inhibitors and inhibitors of reverse transcriptase
2	Technique of targeted drug development
3	Other therapeutics
1	CD-4 mimicking recombinant products
1	Synthetic peptides
1	Improved microbial treatments
12	Vaccine development
3	Many advances in understanding of vaccines in general via HIV work
1	New concepts in vaccine development (e.g., anti-idiotgsic vaccines)
1	Application of genetic engineering techniques, work on animal models
2	Recombinant technologies applied
1	Learning to produce vaccines against agents that mutate rapidly
1	Development of simian AIDS vaccine

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	New vectors, adjuvants, assay systems
1	Progress toward developing viruses for complex viruses
1	Applications of insights into nature of immune response/immunogenecity; nature and function of adjuvants; Advances in techniques of molecular biology/ molecular genetics
1	Other
1	Safer blood banking
41	EPIDEMIOLOGY
7	Biostatistics
1	New methods for conduct of clinical trials and drug evaluation
1	Development of methods for clinical trials with high dropout rates
4	Advances of epidemic modeling techniques
1	Improved data collection techniques
19	Clinical trial development
3	Development of alternative tracks for drug testing
2	Expedited “real world” trials
2	Development of multiple sites and investigators in trials
3	Development of community-based trials
1	Ability to conduct successful clinical trials in non academic setting
4	Negative effect: sanctioning uncontrolled or unsophisticated trials for drug efficacy
2	Stimulated development of cohort studies of surrogate endpoints

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
2	AIDS research has helped overcome special study design problems posed by unique population and risk groups.
11	Disease surveillance
3	Improved methods (e.g., those used by Centers for Disease Control (CDC)), beyond those used for sexually transmitted diseases; Will have major effects on other disease surveillance efforts
	Risk evaluation
	Improved methods of disease ascertainment
	Increased awareness of difficulties of surveillance for a stigmatized disease
	Improved reporting to the CDC
	Surveys by ASPN--more realistic than health department estimates
2	Greater sophistication in techniques of data collection and analysis
	Examination of issues concerning underreporting
4	Natural history of disease
	Large surveys of susceptible and high-risk individuals
	Understanding of behaviors (not groups) that put people at risk
	Better understanding of the behavior of virus in the CNS
	Broader application of role of cofactors, insights into the relationship of immune function and susceptibility of disease
0	Other

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
68	**PUBLIC HEALTH AND HEALTH SERVICES RESEARCH**
14	**Health behavior change**
1	**Stimulated prevention research on relation between alcohol abuse and alcoholism and high risk behavior, particularly unsafe sexual behavior and IV drug use**
1	**Increased study of lifestyle changes that relate to disease prevention**
5	**Increased knowledge of disease leading to change in high risk sexual behavior among homosexual men**
1	**Generally, increased efforts in a traditionally poorly studied area**
1	**Safe sex practices**
1	**Ability of targeted health education to influence behavior of population groups (i.e., homosexuals)**
1	**Brought to forefront risk behaviors clearly related to infection**
2	**Prototype programs for altering behavior-- sexual practices, drug use or abuse**
1	**Studies of behavior change- relationship to knowledge and attitudes**
9	**Health care financing**
1	**Illustrates problems of catastrophic illness**
5	**Focused problems on broader deficiencies in health care financing**
1	**Focus on cost of drugs and drug development**
1	**Raised issues regarding reimbursement for experimental therapies**
1	**identification of gaps in Medicare and Medicaid funding**

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
10	Health care organization and delivery
1	Stimulated prevention, early intervention and treatment research on substance abuse, particularly IV drug use
3	Contributed to understanding long term care issues (not focused on elderly), hospice, nursing homes, particularly use of community supports (i.e., San Francisco model)
1	A better understanding of community-based models of care
2	Expedited knowledge and application of knowledge about out-of- hospital care previously thought necessary in hospitals
1	Demonstration of importance of home care, case management
1	Improved evaluation of treatment programs
1	Negative effect: principles for the control of communicable disease have been grossly compromised
12	Health education
1	Stimulated research on health education and education efforts in preventing high-risk behaviors facilitating HIV infection
2	General education about communicable disease, infection control
1	Education about sexually transmitted diseases (STDS)
3	Improved knowledge of how to design and conduct health education programs to change behavior
1	Has increased sexuality awareness in school systems and institutions
1	Has increased awareness of infection control in industry
1	Has demonstrated clear connection between lifestyle practices and disease infection

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
1	Has demonstrated the use of television and mail for health education campaign
1	Design of focused education and education delivery systems to targeted groups, (e.g., gay men, IV drug users, Blacks, Hispanics) and general population
9	Sexually transmitted disease
1	Routes and mechanisms of transmission
1	Closer attention to other STDs in prevalence studies
2	Refocused awareness on STD's
1	Knowledge about gay sex behavior
1	Knowledge of practices and attitudes of gay community
1	Called attention to lack of knowledge and data on sexual behavior and practices
1	Has shown the interrelationship among STDs
1	Almost all AIDS behavior change research and education strategies are applicable to control of other STDs
5	Sociology/anthropology
1	Better understanding of patterns of sexual behavior among homosexuals and drug-addicted people
1	Understanding of stigma, prejudice, gay behavior
1	Improved survey procedures with hard-to-reach populations
1	Has emphasized our lack of knowledge of sexual attitudes and customs
1	Further understanding of individuals' risk-taking behaviors, social organization, disorganization, ways to alter people's decisionmaking processes

SPECIFIC EXAMPLES-continued

Number of responses	Specific examples (listed by area and field)
9	**Substance abuse**
4	**Increased knowledge and awareness of substance abuse and its patterns**
1	**Had an overall stimulating effect on substance abuse research**
1	**Focused attention on an underfunded discipline--AIDS/HIV research will relate to the broader socio-economic and medical problems that drug abuse creates.**
1	**Demonstrated the connection of substance abuse to other disease**
2	**Increased information about factors leading to substance abuse, about the 'drug culture," about treatment programs**
0	**Other**
2	**OTHER**
1	**Radiology- brought about advances cross sectional imaging**
1	**Increased public awareness of issues in substance abuse and homosexuality**
4	**Additional comments**
1	**In 1979, no human or primate immunodeficiency-causing retrovirus were known. Now there are eight. There are surely many more. Need research to allow us to prevent such illness and disease, rather than respond to it.**
	Too soon to tell the results (spinoffs) of AIDS research. It takes a long time for advances to impact other fields.
	There have been many dividends from the AIDS/HIV research, in many scientific fields. The successful identification of the virus and clarification of its mode of transmission has helped to convince the American public of the quality of biomedical research.
	AIDS research has made little contribution to our overall understanding of basic biology. To the contrary, our understanding of basic biology has made possible all AIDS research.