

the 1984 SCI. Part 1. Names, Ranks, and Citation Numbers

Number 45

November 10, 1986

Over 30 years after his death, Albert Einstein's work continues to be cited by researchers. In 1984 alone, researchers and scholars cited 137 of his works in 336 of their articles. Einstein is but 1 of 250 primary authors whose books and articles were cited at least 448 times according to the 1984 Science Citation Index® (SCI[®]). For this first part of a two-part essay, we compiled the 250 most-cited primary authors for 1984 (see Table 1). We then identified the 180 "new" names in this list, using as a baseline an earlier study of the SCI covering the 15-year period 1961-1975.1 Table 1 includes the 1984 citations for all 250 authors and, for comparison's sake, the 1975 counts for the authors who appeared in the earlier study.

In this essay, notwithstanding a certain ambiguity in the term, "primary" authors are either sole authors of papers or books or the first of several authors listed in bylines. In the second part of this essay we will list the most-cited book or paper for each of the 180 new authors. Most of the publications by authors who work alone are books, as is also often the case for review articles. Many of the journal articles have multiple authors. It is interesting to note that in previous Current Contents® (CC®) studies we found that mathematicians cite books more frequently than articles;2,3 this is also true for social scientists.⁴ But an analysis of most-cited SCI items demonstrated that researchers working in fields covered in that index cite articles four times as often as books.2,5

Long before the SCI began, the majority of active researchers knew that the first author listed on a paper was not always the one who contributed the most to the work. When we compiled the first SCI in 1961, Irv Sher and I agonized over the economics of including all the authors listed on each cited work. We eventually decided to use just first authors, but now, 25 years later, we are examining the possibilities of marketing an electronic version of the Citation Index section of the SCI, searchable by all authors. I'll elaborate on this development later.

Creating the List

For this study we counted all the citations to each name listed in the *Citation Index* section of the 1984 *SCI* and then ranked the names by frequency. We limited our analysis to the top 250 names. This arbitrary threshold was selected simply to reduce the work to manageable proportions and to make it usefully comparable to our earlier study.

Identifying the names was not a simple matter of reading a computer printout, however. Eliminating homographs required detailed examinations of biographical sources to check the addresses and fields for each author. Fortunately, the work we had done in earlier studies, such as the 1,000 contemporary scientists most cited 1965-1978,⁶ made this task significantly easier.

The "New" Authors

The 180 new primary authors are the focus of this essay. Many of their 1984 citation counts surpass those of the older

scientists who appeared previously.¹ For example, U.K. Laemmli, University of Geneva, Switzerland, and M.M. Bradford, Department of Biochemistry, University of Georgia, Athens, each had over 2,500 citations. And 17 new authors, listed in Table 2, were cited over 1,000 times in 1984 alone.

Of these highly cited new authors, Frederick Sanger (UK) was awarded the Nobel Prize in chemistry twice. He was honored first in 1958 for determining the molecular structure of insulin, and more recently in 1980 with Paul Berg and Walter Gilbert of the US for developing methods to map the structure and function of DNA. Linus Pauling (US), who appeared in the older study¹ and is listed here in Table 1, also received the Nobel Prize twice: in 1954 for chemistry for the study of the forces that hold together protein and other molecules, and in 1962 for peace for his work towards international control of nuclear weapons and against nuclear testing.

Thirteen percent of the 250 authors listed are Nobelists. The Nobel Prize, incidentally, was originally supposed to be awarded for research performed the preceding year. However, as I mentioned last week in *Current Comments®*,⁷ the 1985 Nobel Prize in chemistry was won by Herbert A. Hauptman and Jerome Karle for work first done in 1953.⁸ Were that original dictum still followed, our annual studies of most-cited papers would have more relevance.

Many of the new authors have already achieved recognition, or soon will, in the various citation studies we publish every year. For example, J. Ellis, European Organization for Nuclear Research (CERN), Geneva, Switzerland, has six articles in our upcoming study of 1984 physical-sciences articles most cited in 1984 and 1985. G. Arnison, CERN, also appears in that study as the first author of several papers coauthored with Carlo Rubbia, a 1984 Nobel Prize winner in physics. And E. Witten, Joseph Henry Laboratories, Princeton University, New Jersey, has three papers in the 1984 physical-sciences study in addition to appearing here in Table 1. Our study of 1983 chemistry articles most cited in 1983, 1984, and 1985, to be published at the end of this year, includes papers by three most-cited primary authors: A. Bax, Department of Chemistry, Colorado State University, Fort Collins; W.A. Herrmann, Institute for Inorganic Chemistry, University of Frankfurt, Federal Republic of Germany (FRG); and D. Seebach, Organic Chemistry Laboratory, Swiss Federal Institute of Technology, Zurich.

The essay on 1984 life-sciences papers will list papers by M.J. Berridge, Department of Zoology, University of Cambridge and AFRC, Unit of Insect Neurophysiology and Pharmacology, UK; A.S. Fauci, Clinical Center, National Institutes of Health (NIH), Bethesda, Maryland; and R.C. Gallo, National Cancer Institute (NCI), NIH. The latter two authors are involved in acquired immunodeficiency syndrome (AIDS) research. The Gallo team was recently involved in a dispute with the French team of AIDS researchers headed by L. Montagnier, Pasteur Institute, Paris, France, over who first discovered the virus that causes AIDS.9 Both research team leaders were recently named winners of the 1986 Albert Lasker awards for medical research and public service, along with Myron Essex, chairman, Department of Cancer Biology, Harvard School of Public Health, for their work in AIDS.10

Montagnier and colleague F. Barré-Sinoussi, also at the Pasteur Institute, are not included in Table 1 because they did not receive the 448 first-author citations needed for inclusion. Seventeen first-author articles by Montagnier were cited a total of 70 times in 1984; in 1985 Montagnier received 102 citations. Barré-Sinoussi appeared as primary author on three articles that were cited 184 times in 1984. In 1985 she received 377 citations. The most-cited paper for both

 Table 1: The 250 primary authors most cited in the 1984 SCI^{\otimes} . Asterisks (*) indicate that the authors appeared in a previous CC^{\otimes} study of the 1,000 contemporary scientists most cited in the 1965-1978 SCI. Nobel Prizes awarded are shown for chemistry (C), physics (P), and physiology or medicine (M).

			3 J	1				£ 3	ji di
	5					5			
	24		the state			3		د کر کر	36
	22	~ <u>,</u>	2.2			22	e e e	200	×
Abragam A	527	582	608	8	Crommer F	ع ر 660	310		8
Abramowitz M	1.073	1.071	667		*Cromer D T	1.123	802	1.029	
*Ames B N	921	801			*Cuatrecasas P	505	437	1,064	
Anderson PW	885	738	600	'77(P) US	Davis B J	838	826	989	
Armitage P	589	566			DeFronzo R A	520	325		
Arnison G	592	288			de Gennes P G	1,216	868		
Babior B M	457	306			de Vaucouleurs	566	275		
Bard A I	464	304				1 260	500	955	
Barrett A J	579	436			Dixon W J	964	948	,55	
Bartlett G R	551	526			*Doll R	471	360		
*Barton D H R	505	354	510	'69(C) UK	Dubois M	659	639		
Bax A	464	252			Duncan D B	518	512	285	
*Benson S W	545	411	431		Eccles J C	454	340	545	'63(M)
Bergmeyer	790	718			Thursday A	45.4	226		Australia
n-U Berridge M I	571	357			Einstein A	454	330		ZI(P) Germany
Bethe H A	483	407	498	'67(P) US	Ellis I	1.023	477		Octimality
*Beutler E	589	436	449		Ellman G L	599	595		
Binder K	570	345			Engvall E	619	550		
Binkley J S	454	341			*Fairbanks G	515	508		
Birnboim H C	715	705			Fano U	471	368		
Blaustein M P	507	366			Fauci A S	637	486		
*Bohlmonn E	087	080			Fayet P	4/7	211	547	46(D) 116
Bohr A	528	383		'75(P)	Feynman K F	594 678	357	307	03(F) US
boll A	520	505		Denmark	Finney D J	566	532		
Bolivar F	554	509			*Fischer E O	570	242	413	'73(C)
Bonner W M	791	769							FRG
Born M	964	871	721	'54(P) UK	*Fisher M E	547	368	510	
Box G E P	558	430			Fisher R A	648	666	617	
Boyum A	1,328	1,310			Fiske C H	463	463	505	
Bradiord M M	2,342	2,540			*Flow D I	1 225	409	705	74(C) US
*Braunwald E	544	481	375		Folch I	1,078	1.070	820	74(0) 03
*Brown H C	1.266	550	1.153	'79(C) US	*Franke W W	721	379	020	
Brown M S	669	473	•	'85(M) US	Furchgott R F	495	331		
*Burnstock G	506	330			*Fuxe K	680	499		
Burton K	742	735	674		*Gallo R C	494	322		
*Carlsson A	503	395	554		Georgi H	551	328		
Carpenter G	490	332			Gibaldi M	480	424		
*Chance B	737	517	824		*Goldstein I L	804	566		'85(M) US
Chandrasekhar	767	726	594	'83(P) US	Gospodarowicz	553	288		00(11) 00
S					D				
*Chatt J	524	360	521		Graham F L	477	380		
*Churchill M R	583	302			*Graham R C	458	448		
Cleland W W	465	357			Greenblatt D J	697	378		
*Clementi E	531	407/	579		Greenwood	501	501		
Cochran W G	389 4 70	318 474				567	228		
Cohen P	462	387			*Guillemin R	453	415		'77(M) US
Coleman S	523	413			Hagiwara S	464	286		,
*Collman J P	597	390			*Hamberg M	595	419		
*Corey E J	1,860	1,137	1,031		*Hansch C	505	309		
*Cotton F A	1,800	1,187	1,493		Havel R J	448	382		
Cox D R	856	736			Hawking S W	544	336		

			No.	(year, omility)					
	j					the second		Cher of	A LANGE
	< 8	1	Z.			৾ৼৢ৾		~5	<i>خ چ</i>
*Hehre W J *Herberman	501 783	363 510			Mohler H *Moncada S	453 753	279 555		
R B Herrmann	493	127			Moore C E Morley J E	565 659	460 346		
W A Herzberg G	1,027	829	972	'71(C)	*Mott N F Mukaiyama T	1,094 471	807 307	885	'77(P) UK
Hodgkin A L	613	453	505	Canada	Mulliken R S Murashige T	610 496	436 453	725	'66(C) US
*Hoffmann R	602	415		'81(C) US	Nakamoto K	632	585	472	
*Hokfelt T	1,313	857			Nei M	462	284		
*House H O	516	403	504	101/101	Nesmeyanov	573	299	457	
*Hubel D H	600	321	532	'81(M) US	AN	510	24.1		
Huisgen R	609	595	112		Neu H C	518	361		
Inunici W M	466	303 /101		'84(M)	Nicolson G L	504	544 694		
JUNE IV K				Denmark	O'Farrell P H	1.065	1 057		
Johnson C K	738	726		_ OIIIIMI A	*Olah G A	977	477	896	
Jones E G	451	279			Omura T	597	544	070	
Jorgensen C K	482	260	472		Ouchterlony O	486	483	476	
*Kannel W B	691	489			*Palkovits M	462	340		
Kaplan E L	538	525			*Paquette L A	616	271		
*Karnovsky M J	688	655	635		Parisi G	553	335		
Kasuga M	458	271			Pauling L	1,126	966	1,095	'54(C) US
Katritzky A R	544	217	292		Pearse A G E	723	600	775	
*King D D	209	400	550	70(M) UK	Pegg A E	480	244		
Kittel C	455	455	407		Peinam FIK D	581	449 510		
*Klein G	647	470	409		*Pople I A	1 059	800	1 263	
Kohler G	949	855	-107	'84(M)	*Poste G	490	340	1,200	
				FRG	Reinherz E L	1.887	1.019		
Kolthoff I M	493	392	511		Reuter H	492	330		
Korshak V V	451	149			Reynolds E S	690	673	903	
*Krebs H A	448	383	539	'53(M)	Rigby P W J	1,092	1,080		
				UK	*Ross R	755	512		
*Laemmli U K	5,850	5,837		14 A (D)	Rowley J D	451	291		1000
Landau L D	1,838	1,618	1,533	USSR	Salam A	524	453		79(P) Pakistan
*Langer S Z	727	483			*Samuelsson B	528	443		'82(M)
Larsson L I	506	359			l				Sweden
Laskey R A	495	476			*Sandage A	638	329		100/01 197-
Laurell C B	662	609 244			-Sanger F	1,340	1,143		- 60(C) UK,
Lazariues E	472	304 ∦12	160		Scatchard G	1 210	1 197	511	30(C) UK
*Lowry O H	11 009	10 883	7.565		Schoener T W	467	768	511	
Lundberg I M	642	339	1,505		Seebach D	616	200		
MacArthur	507	359			*Seeman P	546	448		
RH	~~/				Sheldrick G M	1,077	1,062		
Main P	715	704			Siegel S	1,278	1,194		
*Malaisse W J	528	202			Sillen L G	476	361	436	
Mancini G	528	526			Slater J C	582	473	650	
Maniatis T	1,941	1,786			Snedecor G W	2,582	2,578	1,395	
Mantel N	522	454			*Snyder S H	515	455		
Marcus R A	551	291			Sokal R R	1,505	1,451		
Maxam A M	1,787	1,744			Sokoloft L	1 994	1.941		
May R M McCord I M	452	200			Southern E M	1,001	1,001		
Messing I	470 804	730			*Sourt A R	514	508		
Mesulam M-M	749	546			Starke K	649	440		
Michell R H	529	364			*Starzl T E	496	293		
Miller J H	871	795			Steel R G D	1,244	1,241	617	
*Mitchell P	561	358	447	'78(C) UK	Steinman R M	522	383		

	Namber of 35 clauser of Notes Pitze (res.
1,132 1,061	< 6 < 8 2 < 7 2 <

LA				
*Stewart R F	511	489		
Still W C	528	453		
Stork G	469	313		
Street R A	482	241		
Swanson L W	754	502		
*Symons M C R	450	165		
Sze S M	450	422		
*Tanford C	731	601	589	
*Thomas E D	551	259		
Thomas P S	668	668		
't Hooft G	825	559		
Towbin H	1,101	1,093		
*Trost B M	1,052	500		
*Turro N J	531	342		
*Umezawa H	462	296		

523

395

Sternberger

Vale W

	5	1 5	7 9 7	
	3	8 <u>1</u>		
	12	2 ž	15	
	< <u>8</u>	1	~6	1
Vogel A I	702	671		
Voller A	500	430		
*Wagner H	593	470		
Wahl G M	469	446		
Weber G	577	388	507	
*Weber K	1,443	1,378	1,481	
*Weibel E R	855	659		
*Weinberg S	1,276	932	734	'79(P) US
*Wilson K G	520	380		'82(P) US
Winer B J	862	860	622	
Witten E	953	660		
Wright S	558	339		
Yaksh T L	567	316		
Yamada K M	487	337		
*Yunis J J	462	325		
Zakharov V E	453	285		
Zar J H	583	583		
Zeldovich Y B	730	548	473	

33

authors is a 1983 Science article entitled "Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS)."¹¹ In 1983 it was cited 27 times; in 1984, 146; and in 1985, 362. Essex does not appear in Table 1 either. His most-cited work was also published in Science in 1983¹² and was cited 251 times from 1983 to 1985. His total 1984 citations were 240; in 1985 this number was 161. These examples are but a few that can be discussed to show how inconsistent first- or primary-author data can be.

Sixty-eight articles by J.L. Goldstein, Departments of Molecular Genetics and Cell Biology, University of Texas Health Science Center, Dallas, received over 800 total citations in 1984. Goldstein received the Nobel Prize in physiology or medicine in 1985 with M.S. Brown, Department of Internal Medicine, also at the University of Texas Health Science Center, for their work on cholesterol.13 Sixty-six of Brown's papers were quoted 670 times in 1984. R. Guillemin, Salk Institute for Biological Studies, La Jolla, California, is also a recent Nobel recipient. His work with A.V. Schally investigating the role of hormones in body chemistry was acknowledged by award

of the prize for physiology or medicine in 1977. R.S. Yalow shared this prize with them for work in this same area. Table 1 lists 43 works by Guillemin that were cited over 450 times in 1984.

Many of the authors in this study perform research in the life sciences. This is often the case in citation-based studies because of the amount of publication in those disciplines. Also, the average biomedical or biochemistry paper tends to give out more references than the typical physical-sciences article. Of course, Table 1 also includes authors from the physical sciences, chemistry, and several smaller fields such as statistics (P. Armitage, Department of Biomathematics, University of Oxford; G.W. Snedecor, Department of Statistics, Harvard University, Cambridge, Massachusetts), crystallography (C.K. Johnson, Oak Ridge National Laboratory, Tennessee), atomic energy (C.E. Moore, Atomic and Molecular Physics Division, National Bureau of Standards [NBS], Washington, D.C.), and psychology (S. Siegel, Department of Psychology, Pennsylvania State University, University Park). Much of psychology is traditionally covered in the Social Sciences Citation Index[®] (SSCI[®]), but experimental psychology appears in the SCI.

Table 2: Authors not included in the previous primary-authors study who were cited over 1,000 times in the 1984 *SCI*[®]. Names are listed alphabetically. Asterisks (*) indicate authors who received these citations from over 1,000 articles in 1984.

Author and Affiliation

*A. Boyum, Division of Toxicology, Norwegian Defense Research Establishment, Kjeller, Norway *M.M. Bradford, Department of Biochemistry, University of Georgia, Athens

- P.G. deGennes, Solid State Physics Laboratory, College of France, Paris
- J. Ellis, European Organization for Nuclear Research (CERN), Geneva, Switzerland
- T. Hokfelt, Department of Histology, Karolinska Institute, Stockholm, Sweden
- *U.K. Laemmli, University of Geneva, Switzerland
- *T. Maniatis, Harvard University, Cambridge, Massachusetts
- *A.M. Maxam, Department of Biochemistry and Molecular Biology, Harvard University
- *P.H. O'Farrell, Department of Molecular, Cellular, and Developmental Biology, University of Colorado, Boulder
- *E.L. Reinherz, Division of Tumor Immunology, Sidney Farber Cancer Institute, Boston, Massachusetts
- *P.W.J. Rigby, Department of Biochemistry, Stanford University Medical Center, California
- *F. Sanger, MRC Laboratory of Molecular Biology, Cambridge, UK
- *G.M. Sheldrick, University of Cambridge, UK
- *S. Siegel, Department of Psychology, Pennsylvania State University, University Park
- *R.R. Sokal, Department of Entomology, University of Kansas, Lawrence
- *E.M. Southern, Department of Zoology, University of Edinburgh, Scotland
- *L.A. Sternberger, Johns Hopkins University School of Medicine, Baltimore, Maryland
- *H. Towbin, Friedrich-Miescher Institute, Basel, Switzerland
- B.M. Trost. Department of Chemistry, University of Wisconsin, Madison

Other Authors and General Statistics

O.H. Lowry, School of Medicine, Washington University, St. Louis, Missouri, was the most-cited author in the previous study of primary authors, with 58,000 citations from 1961 to 1975. In 1975 he was cited 7,600 times. Thirtyfive years after the publication of his 1951 paper,14 it and 94 of his other firstauthored works were cited nearly 11,000 times by nearly the same number of articles. The 1951 paper received 10,350 of these. We have discussed Lowry's methodological research papers many times in previous essays. Since his uniquely high citation count skews the calculation of average citation frequency for authors in Table 1, we deleted it from that computation. This results in an average. or mean citation frequency, of 722 and a median frequency of 445. For all cited authors in the 1984 SCI the average was eight.

The correlation is high between 1975 and 1984 citations for the authors who appeared in the previous study. Citations to 51 of these 70 authors increased from 1975 to 1984, in some cases rather

dramatically. For example, the number of times the work of G. Scatchard, Massachusetts Institute of Technology, Cambridge, was referenced more than doubled from 1975 to 1984, from 500 citations to 1,200. Other authors with significant increases include M. Abramowitz, Commerce Department, NBS; E.J. Corey, Department of Chemistry, Harvard University; D.B. Duncan, Department of Biostatistics, Johns Hopkins University; P.J. Flory, Department of Chemistry, Stanford University, California; A.R. Katritzky, Department of University of Florida, Chemistry, Gainesville; Snedecor; R.G.D. Steel, Department of Statistics, North Carolina State University, Raleigh; S. Weinberg, Department of Physics, University of Texas, Austin; and Y.B. Zeldovich, Institute for Physical Problems, Academy of Science of USSR, Moscow.

First-author citations to P. Cuatrecasas, Wellcome Research Laboratories, Burroughs Wellcome Company, Research Triangle Park, North Carolina, on the other hand, dropped from over 1,060 in 1975 to 500 citations in 1984. Fifty-seven of his papers were cited in

1984 compared to 79 in 1975. References to E.S. Reynolds, Department of Pathology, University of Texas Medical Branch, Galveston, also decreased significantly, but about the same number of papers were cited in 1975 and 1984. In contrast, J. Chatt, School of Chemistry and Molecular Sciences, University of Sussex, Brighton, UK, received nearly the same number of citations-about 520-in 1975 and 1984 as did D.H.R. Barton, Institute of Chemistry of Natural Substances. CNRS, Gif-sur-Yvette. France; H.O. House, Department of Chemistry, Georgia Institute of Technology, Atlanta; C.K. Jorgensen, Mineral Analytical and Applied Chemistry Department, University of Geneva, Switzerland; O. Ouchterlony, Department of Bacteriology, University of Gothen-burg, Sweden; and K. Weber, Max Planck Institute for Biophysical Chemistry, Göttingen-Nikolausber, FRG.

Note that the entire SCI database increased nearly 60 percent from 1975 to 1984. In 1975 we processed nearly 5,500,000 cited references—in 1984, 8,777,000. (The 250 authors in this study received about 191,000, or 2 percent, of these references.) The number of unique cited primary authors rose from the 772,500 listed in the 1975 SCI to 1,070,000 in 1984. (The 250 authors represent 0.02 percent of these.)

The number of source items indexed in the 1984 SCI totaled approximately 570,000; there were 4,440,000 unique cited items. In 1975 these figures were 418,900 and 3,006,000, respectively. Incidentally, the ratio of citations, or references, given out each year to the number of different items cited by those references, also known as Garfield's "constant," was 2.0 in 1984 and 1.8 in 1975. This figure has, in general, been slowly rising since we first calculated it in the 1964 SCI. That year it was 1.7.15

Unique Citing Articles

In addition to 1975 and 1984 citations, Table 1 also lists the number of 1984 articles that cited each author's works. These unique citing articles, listed in the second column, frequently differ significantly from the number of 1984 citations because they indicate how many articles cited an author. A researcher's work has probably had greater impact on other scientists if that work has been cited by many different sources rather than many times by just a few sources. Remember that a single review article may cite dozens of papers by an author prominent in a particular field. So, in some respects, the citing article's impact may tell us more about the breadth of an author's impact on other scientists and fields. In some cases it may simply reflect the use of a particular method. For example, Laemmli received 5,850 citations from a nearly identical number of papers that primarily cited a single paper published in 1970. It will be discussed in Part 2 of this essay.

The approximately 2,540 citations to Bradford also came from about the same number of items and were given out to just 20 different articles. In contrast, 188 papers by Ellis received over 1,020 citations from nearly 480 articles. And the 92 cited articles by Herrmann received over 490 citations in 1984, but he was actually cited *in* only 127 separate papers. These differences may be less important in the natural sciences, but in the humanities these distinctions are crucial. And in all fields they provide a different perspective on the number of scholars influenced by the author in question.

Lowry was cited in the largest number of articles in 1984—over 10,880—while Herrmann's 127 is the lowest in Table 1. When we ranked the primary authors by the number of articles that cited them in 1984 rather than the total citations they received that year, we observed that 884 authors were cited by at least 127 articles. Had we selected the top 250 primary authors by citing articles, the cutoff would have been 336. Einstein just meets this cutoff point. But 54 of the names in the table in this essay, includ-

ing 48 new ones, drop below this threshold, including Arnison; Gallo; H. Georgi, Physics Department, Harvard University; V.V. Korshak, USSR Academy of Sciences, Moscow; M. Nei, Center for Demographic and Population Genetics, University of Texas, Houston; and V.E. Zakharov, Institute of Hydrodynamics, USSR Academy of Sciences, Novosibirsk. Some of the names that move up into the listing of the 250 with the greatest number of 1984 citing articles are D.I. Arnon, Department of Cell Physiology, University of California, Berkeley; R.W. Davis, Department of Biochemistry, Stanford University; I.S. Gradshteyn, Soviet mathematician; L. Onsager, Sterling Chemistry Laboratory, Yale University, New Haven, Connecticut; J.G. Sutcliffe, Department of Cellular and Developmental Immunology, Scripps Clinic and Research Foundation, La Jolla, California; M.H. Julius, Department of Genetics, Stanford University School of Medicine; and A.G. Gornall, Department of Clinical Biochemistry, University of Toronto, Canada, to name a few.

Name-Ordering Patterns

Before I conclude this first part of our primary-authors study, I would like to acknowledge the problems of using primary-author data. Name ordering on papers is a topic that many scholars have discussed. For example, in 1968 Harriet A. Zuckerman, Department of Sociology, Columbia University, New York, discussed patterns of name ordering among Nobel Prize winners in an article aptly subtitled "A study of social symbolism and its ambiguity." She found that with respect to multiple-authored scientific papers, different methods for ordering names had presumably evolved as attempts to lessen the ambiguity in assigning credit. The alphabetic order of listing names was one increasingly popular pattern;16 it was already a traditional sequence long followed in the UK.17,18

Zuckerman also found that occupying visible positions in name-ordering sequences was more important to younger scientists, who were still relatively unknown, than to older, established scientists, particularly Nobelists whose names were already familiar to their colleagues.¹⁶

If scientists appear less often as primary authors as they advance in their careers, and this seems to be true of biochemists according to a 1980 study,19 they may be overlooked in lists such as Table 1. For example, Sheldon Glashow, Lyman Laboratory of Physics, Harvard University, a 1979 Nobelist in physics, does not appear in the list, but he has, nevertheless, coauthored many highly cited works, one of which appeared in our recent study of the 1,000 most-cited SCI papers, 1961-1982.20 And he is a coauthor on the most-cited paper of Georgi, who does appear in Table 1. His most-cited paper will be listed in Part 2 of this essay. Of course some senior authors may be unaffected by this problem because they publish enough highly cited articles by themselves in addition to those in which they appear as coauthors.

Conclusion

In the near future we plan to aggregate citations to all authors listed on papers by creating an International Science Indicators Database. It will unify the 30 years of source publications covered by the SCI, SSCI, and Arts & Humanities Citation IndexTM (A&HCITM). This statistically oriented database will list all the authors of a paper, their institutional addresses, the journal that published the paper, the full title of the article, field and area of specialty of the article, and its citation counts for each year since 1955. This 30-year file will be fully searchable by the categories listed above, including all authors, thus enabling us to identify most-cited authors regardless of the positioning of their names on papers.

Until that database is a reality, however, it is still useful and interesting for us to identify a sample of prominent primary authors and their most-cited works; the latter will be listed in Part 2 of this essay.

APPENDIX

We remind readers that the Source Index section of the SCI does include allauthor data. We cannot include this information in the Citation Index section because it would triple the size of this already lengthy bibliographic tool. How-

ever, searching the SCI, SSCI, and A&HCI using the all-author approach is now possible with ISI®'s Automatic Subject Citation Alert (ASCA®). This cuscurrent-awareness service tomized searches the current journal literature for every new item related to a subscriber's interests. I discussed this enhancement to ASCA in a 1985 essay.21

My thanks to Abigail W. Grissom and Janet Robertson for their help in the preparation of this essay. C 1986 ISI

* *

REFERENCES

- 1. Garfield E. The 250 most-cited primary authors, 1961-1975. Parts 1-3. Essays of an information scientist. Philadelphia: ISI Press, 1980. Vol. 3. p. 326-63.
- Vol. 7. p. 264-9.
- 3. ----- The multidisciplinary impact of math and computer science is reflected in the 100 most-
- 5. -----. Selecting the all-time Citation Classics. Here are the fifty most-cited papers for 1961-1972; and the second fifty papers most cited from 1961-1972.

- 7. The 1985 Nobel chemistry prize to Jerome Karle and Herbert A. Hauptman and the physics prize to Klaus von Klitzing contrast delayed versus "instant" recognition. Current Contents (44):3-12, 3 November 1986.
- Hendrickson W A. The 1985 Nobel Prize in chemistry. Science 231(4737):362-4, 1986.
 Norman C. AIDS priority fight goes to court. Science 231(4733):11-2, 1986.
- 10. Schmeck H M. AIDS research rivals share a major award.
- New York Times 23 September 1986. p. C1; C3.
- 11. Barré-Sinoussi F, Chermann J C, Rey F, Nugeyre M T, Chamaret S, Gruest J, Dauguet C, Axler-Blin C, Vézinet-Brun F, Rouzioux C, Rozenbaum W & Montagnier L. Isolation of a T-lymphotropic retrovirus from a patient at risk for acquired immune deficiency syndrome (AIDS). Science 220:868-71, 1983
- 12. Essex M, McLane M F, Lee T H, Falk L, Howe C W S, Mullins J I, Cabradilla C & Francis D P. Antibodies to cell-membrane antigens associated with human T-cell leukemia virus in patients with AIDS. Science 220:859-62, 1983.
- 13. Garfield E. The 1985 Nobel Prize in medicine-Michael S. Brown and Joseph L. Goldstein have revolutionized our knowledge about cholesterol, metabolism, and heart disease. Current Contents (38):3-13, 22 September 1986.
- 14. Lowry O H, Rosebrough N J, Farr A L & Randall R J. Protein measurement with the Folin phenol reagent. J. Biol. Chem. 193:265-75, 1951.
- 15. Garfield E. Is the ratio between number of citations and publications cited a true constant? Essays of an information scientist. Philadelphia: ISI Press, 1977. Vol. 2. p. 419-21.
- Zuckerman H A. Patterns of name ordering among authors of scientific papers: a study of social symbolism and its ambiguity. *Amer. J. Sociol.* 74:276-91, 1968.
- 17. Garfield E. The ethics of scientific publication. Essays of an information scientist.
- Philadelphia: ISI Press, 1980. Vol. 3. p. 644-51.
- 18. Farr A D. Multiple authorship of scientific papers. Med. Lab. Sci. 41:1-2, 1984.
- Long J S, McGinals R & Allison P D. The problem of junior-authored papers in constructing citation counts. Soc. Stud. Sci. 10:127-43, 1980.
- 20. Garfield E. The articles most cited in 1961-1982. Parts 1-10. Current Contents (23):3-9, 4 June 1984; (29):3-12, 16 July 1984; (35):3-9, 27 August 1984; (40):3-9, 1 October 1984; (42):3-12, 15 October 1984; (14):3-10, 8 April 1985; (20):3-12, 20 May 1985; (33):3-11, 19 August 1985; (8):3-12, 24 February 1986; (16):3-14, 21 April 1986.
- awareness needs. Current Contents (40):3-9, 7 October 1985. (Reprinted in: Essays of an information scientist: ghostwriting and other essays. Philadelphia: ISI Press, 1986. Vol. 8. p. 379-85.)

Ibid., 1977. Vol. 2. p. 6-9; 21-5.