Essays of an Information Scientist, Vol:3, p.538-550, 1977-78 Current Contents, #28, p.5-17, July 10, 1978

CURRENT COMMENTS

The 300 Most-Cited Authors, 1961-1976, Including Co-Authors at Last. 1. How the Names Were Selected

Number 28, July 10, 1978

Recently we listed and analyzed the 250 most-cited primary authors.[1-4] In compiling these "most-cited" lists, we tested the assumption that frequent citation is an indication of significance in science. Of course, capricious or ill-chosen references may account for some citations. And sometimes papers are cited in order to criticize them. But if an author is consistently cited, indeed thousands of times over a number of years, this record indicates (with occasional exceptions) that he or she has made a significant impact on science.

Our assumption was borne out in our study of primary authors. By analyzing their various academy memberships and awards, we showed that their citation ranking correlated fairly well with peer recognition. The scientists on the primary-author list are members of an elite group, past and present, who have had a great effect on science through their research publications.

But no matter how far we might have extended our list—even to the first several thousand names—we could be seriously criticized for omissions, due to a convention involved in compiling the *Citation Index* section of the *Science Citation Index®* . In this section we record only the names of the first authors of cited items. Co-authors' names are included only in our *Source Index*.

Co-authorship was less frequent in the early part of this century. But it has increased significantly since the 1950s. It was inevitable that the "primary author" approach would overlook many important authors who have published significant work as co-authors in the last twenty years.

Therefore, we felt it imperative to produce data that would include the citations scientists had received as co-authors. I hope that those who have felt slighted by our earlier studies will appreciate how difficult it has been to do this.

Recently we ran the ISI® computer day and night for about a month to collect data for our first "all-author" study. Over 10 million *Source Index* author entries in our *Science Citation Index* data base were matched against millions of citations in the *Citation Index*. The

source file consists of all the articles published during the period 1961-1976 which were covered by the *SCI®* . The "citation" file consists of all the references made by these articles in the same period.

To obtain this all-author information, we had to make certain compromises. The *Source Index* file of the *Science Citation Index* data base contains the names of all authors of source items covered by *SCI* from 1961 on. Thus, our "all-author" analysis is only as complete and reliable as that file.

Since our *Source Index* file begins with 1961, citations to papers published prior to that year are excluded. Out of 56 million citations, 24 million were thus excluded. This chronological bias distorts rankings for those scientists who published their most important papers prior to 1961. Also, obviously, authors who have been publishing steadily since 1961 fare better in this analysis than, say, those who started in 1971.

However, this bias will shift as we produce similar reports from year to year.

Since the analysis was limited to articles appearing in journals indexed by *SCI,* authors who published in journals which were not covered would not be treated evenly. Fortunately, our original selection of journals included all but a few of those most frequently cited. This original group of periodicals still receives over 75% of all citations. However, in our earlier files, certain fields such as botany and mathematics were not covered as comprehensively as they are today. But for the basic life and physical sciences, the file is essentially complete.

Finally, by limiting our "data bank" for this study to the items covered by *SCI,* we restricted the cited items to journal articles. The *SCI* indexed only the journal literature until 1977, when it began to cover books.

It is important to remember these compromises when you scan the list of most-cited authors based on "all-author" data which begins on page 7.

It is also essential to realize that this list and the earlier "250 most-cited primary authors" list are very different, because the all-author list includes only citations to papers published 1961-1976. For example, L. D. Landau, who was a highly cited *primary* author (with over 18,000 citations), is not on the "all-author" list because his highly cited work was done prior to 1961. However, his early papers continue to be heavily cited.

Scientists on the primary-author list who received most of their citations for books or other reports not published in journals do not appear on this list either. The "all-author" list is limited to those who were primary and co-authors of highly cited journal articles which were published 1961-1976 and covered by the *SCI* during that time period.

Only 77 authors from the "250 most-cited primary authors" list appear on the "all-author" list. Each is identified by an asterisk which precedes his or her name. As the

Figure 1: The 300 authors whose articles published 1961-1976 were most-cited during that time period. Based on *Science Citation Index®* data, the list shows citations for *co-authored* as well as primary-authored articles. An asterisk before a name indicates that the author also appeared in the 250 most-cited *primary* authors list.

Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Organic & Inorganic Chemistry						
*Bender ML (1924)	5,131	148	3,029	69	2,102	79
*Benson SW (1918)	4,359	157	2,239	52	2,120	105
*Brown HC (1912)	10,288	400	8,337	289	1,951	111
*Clementi E (1931)	5,440	92	4,819	61	621	31
*Corey EJ (1928)	8,500	247	7,646	229	854	18
*Cotton FA (1930)	10,292	350	7,664	250	2,628	100
*Cram DJ (1919)	3,827	164	2,057	58	1,770	106
Davidson ER (1936)	3,757	60	436	24	3,321	36
*Dewar MJS (1918)	6,635	224	4,805	168	1,830	56
*Djerassi C (1923)	11,027	431	2,118	77	8,909	354
Drago RS (1928)	4,178	165	984	38	3,194	127
*Flory PJ (1910)	5,538	133	2,079	49	3,459	84
Grant DM (1931)	3,869	90	896	12	2,973	78
Gray HB (1935)	4,526	175	988	20	3,538	155
Hammond GS (1921)	5,129	141	1,859	38	3,270	103
Hoffmann R (1937)	7,969	125	5,761	61	2,208	64
*Huisgen R (1920)	4,996	242	3,965	166	1,031	76
Ibers JA (1930)	6,452	209	919	29	5,533	180
Jortner J (1933)	4,821	197	1,144	42	3,677	155
*Karplus M (1930)	6,193	128	3,063	25	3,130	103
Khorana HG (1922)	6,620	174	770	12	5,850	162
*King RB (1938)	4,583	252	3,656	207	927	45
Kochi JK (1928)	3,919	159	2,151	55	1,768	104
Li CH (1913)	3,908	248	1,212	65	2,696	183
Lipscomb WN (1919)	6,364	218	495	20	5,869	198
Muetterties EL (1927)	3,883	128	2,193	58	1,690	70
Nemethy G (1934)	3,927	43	2,214	17	1,713	26
*Olah GA (1927)	7,451	380	6,683	346	768	34
Paquette LA (1934)	3,819	270	3,448	235	371	35
*Pople JA (1925)	10,479	121	6,287	33	4,192	88
*Roberts JD (1918)	6,088	196	118	6	5,970	190
Robins RK (1926)	4,239	247	167	6	4,072	241
Samuelsson B (1934)	5,849	148	1,019	27	4,830	121
Scherage HA (1921)	9,232	280	315	14	8,917	266
Schleyer PV (1930)	5,806	169	1,484	29	4,322	140
Sŏrm F (1913)	5,858	492	261	17	5,597	475
Stewart RF (1936)	3,894	52	3,219	42	675	10
Sweeley CC (1930)	4,424	85	2,124	14	2,300	71
*Tanford C (1921)	5,888	107	1,638	28	4,250	79
*Winstein S (1912-69)	4,522	162	1,302	26	3,220	136
Witkop B (1917)	4,341	194	70	5	4,271	189
*Woodward RB (1917)	4,044	48	2,292	24	1,752	24

Figure 1. The 300 most-cited authors, 1961-1976.

Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Biochemistry						
Allfrey VG (1921)	6,069	79	1,461	15	4,608	64
Ames BN (1928)	6,689	69	1,925	19	4,764	50
*Andrews P (1928)	4,606	50	4,385	27	221	23
Anfinsen CB (1916)	4,942	119	452	14	4,490	105
Brady RO (1923)	3,744	143	1,758	51	1,986	92
Cleland WW (1930)	4,652	63	3,421	15	1,231	48
*Cuatrecasas P (1936)	6,777	142	4,932	62	1,845	80
*DeDuve C (1917)	4,178	50	1,754	15	2,424	35
Deluca HF (1930)	8,622	275	825	31	7,797	244
Doty P (1920)	7,422	86	38	4	7,384	82
Edelman GM (1929)	6,797	127	2,934	29	3,863	98
Estabrook RW (1926)	4,546	109	818	23	3,728	86
Hales CN (1935)	3,936	67	2,479	18	1,457	49
Harris H (1919)	4,326	117	909	25	3,417	92
Horecker BL (1914)	4,529	154	334	13	4,195	141
Jencks WP (1927)	4,299	126	932	25	3,367	101
Kaplan NO (1917)	7,248	180	660	11	6,588	169
*Kornberg A (1918)	6,706	115	424	8	6,282	107
Koshland DE (1920)	5,136	120	1,495	19	3,641	101
Krebs EG (1918)	4,043	63	353	2	3,690	61
*Krebs HA (1900)	5,146	93	1,607	33	3,539	60
Lardy HA (1917)	4,954	131	761	11	4,193	120
*Lehninger AL (1917)	4,651	119	1,286	23	3,365	96
Lipmann F (1899)	5,019	75	203	7	4,816	68
*Moore S (1913)	5,619	121	1,646	36	3,973	85
Morris HP (1900)	4,319	282	68	5	4,251	277
Ochoa S (1905)	4,172	95	267	8	3,905	87
Passonneau JV (1924)	4,034	61	821	9	3,213	52
Plez KA (1924)	4,302	61	1,399	20	2,903	41
Prockop DJ (1929)	5,187	142	1,064	23	4,123	119
Randle PJ (1926)	6,442	92	897	9	5,545	83
Reich E (1927)	4,996	87	1,929	17	3,067	70
Rodbell M (1925)	4,037	47	2,478	23	1,559	24
Roseman S (1921)	4,068	105	765	7	3,303	98
Rutter WJ (1928)	4,147	85	536	8	3,611	77
Seegmiller JE (1920)	4,690	166	1,121	23	3,569	143
Smith EL (1911)	3,861	113	466	16	3,395	97
Tappel AL (1926)	4,665	158	483	15	4,182	143
*Udenfriend S (1918)	10,507	200	1,180	15	9,327	185
Umezawa H (1914)	5,781	501	1,319	53	4,462	448
Vallee BL (1919)	5,527	179	714	18	4,813	161
Van Deenen LL (1928)	6,873	214	521	13	6,352	201
Immunology						
Austen KF (1928)	6,023	253	554	24	5,469	229
Benacerraf B (1920)	9,197	239	1,359	26	7,838	213
Cooper MD (1945)	3,905	108	1,663	33	2,242	75
*Fahey JL (1924)	6,482	140	3,494	47	2,988	93

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Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Immunology (continued)						
Finland M (1902)	4,082	165	323	29	3,759	136
Franklin EC (1928)	4,358	175	981	49	3,377	126
Fudenberg HH (1928)	7,523	332	707	30	6,816	302
*Good RA (1922)	17,641	694	680	36	16,961	658
Grey HM (1932)	3,788	86	1,511	34	2,277	52
Haber E (1932)	4,638	153	1,338	27	3,300	126
Hirschhorn K (1926)	4,548	193	1,608	31	2,940	162
Ishizaka K (1925)	4,947	190	2,348	66	2,599	124
*Kunkel HG (1916)	9,031	200	942	26	8,089	174
Merrill JP (1917)	5,262	235	464	29	4,798	206
Moller G (1936)	4,383	109	1,961	51	2,422	58
Muller-Eberhard HJ (1927)	5,924	144	1,089	16	4,835	128
Nossal GJV (1931)	3,985	99	2,374	54	1,611	45
Paul WE (1936)	4,189	126	592	27	3,597	99
Pressman D (1916)	3,726	240	127	10	3,599	230
Reisfeld RA (1926)	4,559	109	2,052	21	2,507	88
Roitt IM (1927)	3,902	103	513	11	3,389	92
Rosen FS (1930)	4,149	148	779	29	3,370	119
Sela M (1924)	4,987	238	841	24	4,146	214
Terasaki PI (1929)	5,174	176	1,076	26	4,098	150
Waksman BH (1919)	4,730	145	1,143	34	3,587	111
Wigzell H (1938)	4,046	85	719	16	3,327	69
Endocrinology						
Aurbach GD (1927)	3,887	100	375	14	3,512	86
Bartter FC (1914)	3,736	176	756	25	2,980	151
*Berson SA (1918-72)	5,474	64	1,930	27	3,544	37
Conn JW (1907)	3,938	108	1,527	27	2,411	81
Daughaday WH (1918)	3,731	101	676	20	3,055	81
Greenwood FC (1927)	5,572	42	2,732	8	2,840	34
Guillemin R (1924)	4,200	128	632	25	3,568	103
Hunter WM (1929)	5,214	64	2,537	24	2,677	40
Kastin AJ (1934)	3,852	166	1,437	54	2,415	112
Kipnis DM (1927)	4,805	111	345	8	4,460	103
Laragh JH (1924)	4,763	134	1,263	38	3,500	96
Lever AF (1929)	3,884	127	326	7	3,558	120
Liddle GW (1921)	4,483	105	538	15	3,945	90
Lipsett MB (1921)	3,912	112	661	30	3,251	82
Midgley AR (1933)	5,108	101	1,540	21	3,568	80
Pastan I (1931)	5,997	145	1,644	41	4,353	104
Potts JT (1932)	4,148	148	568	13	3,580	135
Rasmussen H (1925)	4,489	133	2,128	49	2,361	84
Roth J (1934)	5,647	159	1,635	50	4,012	109
Schally AV (1926)	10,386	430	2,378	80	8,008	350
Unger RH (1924)	4,623	124	1,997	36	2,626	88
Wilson JD (1932)	4,140	147	1,745	72	2,395	75
*Wurtman RJ (1936)	6,170	223	3,175	74	2,995	149
Yalow RS (1921)	5,595	82	1,569	27	4,026	55

Figure 1. The 300 most-cited authors, 1961-1976.

Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Molecular Biology						
Baltimore D (1938)	5,270	111	2,505	32	2,765	79
Berg P (1926)	5,307	111	645	15	4,662	96
Bonner J (1910)	7,096	121	1,523	21	5,573	100
Changeux JP (1936)	6,208	109	1,841	27	4,367	82
Gros F (1925)	3,712	104	743	8	2,969	96
Hurwitz J (1928)	4,873	102	1,318	16	3,555	86
*Jacob F (1920)	10,383	115	4,990	21	5,393	94
Leder P (1934)	3,892	70	683	20	3,209	50
Maizel JV (1934)	4,807	50	1,076	12	3,731	38
*Marmur J (1926)	10,254	87	5,856	23	4,398	64
*Monod J (1910-76)	6,945	33	3,079	7	3,866	26
Nomura M (1927)	5,100	147	2,089	49	3,011	98
*Perutz MF (1914)	4,734	61	3,475	37	1,259	24
*Racker E (1913)	4,876	141	997	33	3,879	108
Rich A (1924)	6,075	168	784	20	5,291	148
Schimke RT (1932)	4,816	76	2,254	22	2,562	54
Singer SJ (1924)	4,422	83	1,964	12	2,458	71
Szybalski W (1921)	3,753	84	499	10	3,254	74
Tomkins GM (1926-75)	6,157	135	1,171	20	4,986	115
Vinograd J (1913-76)	4,956	75	1,240	10	3,716	65
Weissbach H (1932)	4,112	163	685	31	3,427	132
Pharmacology						
*Anden NE (1937)	4,475	95	4,172	84	303	11
*Axelrod J (1912)	15,769	308	2,633	50	13,136	258
*Brodie BB (1909)	6,246	152	1,400	40	4,846	112
*Carlsson A (1923)	4,786	117	3,971	80	815	37
*Conney AH (1930)	6,366	143	3,098	32	3,268	111
Corrodi H (1929-74)	4,366	76	2,536	38	1,830	38
Costa E (1924)	3,994	184	543	22	3,451	162
*Curtis DR (1927)	3,728	88	2,985	65	743	23
Fuxe K (1938)	8,888	203	1,456	52	7,432	151
Gillette JR (1928)	3,869	136	594	25	3,275	111
Glowinski J (1936)	4,502	117	1,935	17	2,567	100
Greengard P (1925)	4,916	104	445	21	4,471	83
Iversen LL (1937)	5,833	128	2,608	60	3,225	68
Kopin IJ (1929)	6,694	217	1,790	29	4,904	188
Levy G (1928)	3,898	255	2,213	136	1,685	119
*Lowry OH (1910)	4,867	81	2,299	19	2,568	62
Robison GA (1934)	4,051	48	1,744	15	2,307	33
Sjoerdsma A (1924)	6,479	156	500	13	5,979	143
Snyder SH (1938)	6,687	211	2,131	59	4,556	152
*Sutherland EW (1915-74)	11,644	92	2,158	10	9,486	82
Vane JR (1927)	6,292	138	1,573	17	4,719	121

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Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Cell Biology						
Aaronson SA (1942)	3,821	113	1,782	33	2,039	80
*Allison AC (1925)	5,807	187	3,434	86	2,373	101
Barrnett RJ (1920)	5,945	100	178	6	5,767	94
Brenner S (1927)	6,334	78	1,364	19	4,970	59
Busch H (1923)	4,736	256	420	29	4,316	227
*Davis BJ (1932)	7,602	13	7,436	1	166	12
Ernster L (1920)	5,884	120	1,651	21	4,233	99
*Farquhar MG (1928)	5,149	48	3,106	15	2,043	33
*Green DE (1910)	5,482	161	2,265	69	3,217	92
Green H (1925)	4,338	89	642	19	3,696	70
Leblond CP (1910)	5,165	90	119	5	5,046	85
McCulloch EA (1926)	4,417	82	603	11	3,814	71
*Palade GE (1912)	11,242	104	478	7	10,764	97
Penman S (1930)	7,124	101	2,278	15	4,846	86
*Porter KR (1912)	4,221	65	523	19	3,698	46
*Sabatini DD (1931)	4,649	23	4,164	8	485	15
Sachs L (1924)	5,982	176	333	14	5,649	162
Sandberg AA (1921)	4,489	171	1,467	40	3,022	131
Weissmann G (1930)	5,210	164	2,975	80	2,235	84
Physiology						
Arimura A (1923)	5,278	210	934	41	4,344	169
Brown JJ (1928)	3,892	148	2,797	85	1,095	63
Butcher RW (1930)	6,875	48	3,020	13	3,855	35
*Carlson LA (1928)	4,002	146	2,316	89	1,686	57
*Eccles JC (1903)	4,579	108	3,238	84	1,341	24
*Fredrickson DS (1924)	7,871	128	4,929	28	2,942	100
*Hubel DH (1926)	4,474	35	3,572	24	902	11
Lassen NA (1926)	4,004	121	1,715	40	2,289	81
McCann SM (1925)	4,956	176	657	15	4,299	161
Meites J (1913)	4,665	183	599	15	4,066	168
Mirsky AE (1900-74)	5,083	61	206	8	4,877	53
Munro HN (1915)	4,414	143	809	32	3,605	111
Odell WD (1929)	3,720	109	1,505	28	2,215	81
Page IH (1901)	5,161	178	728	52	4,433	126
Park CR (1916)	3,763	72	55	3	3,708	69
Robertson JI (1928)	3,705	135	83	3	3,622	132
Starzl TE (1926)	4,901	190	2,354	75	2,547	115
Waldmann TA (1930)	4,088	111	1,657	31	2,431	80
Wiesel TN (1924)	4,605	34	872	7	3,733	27
Microbiology & Virology						
Blumberg BS (1925)	6,029	173	2,850	63	3,179	110
Chanock RM (1924)	7,659	219	1,807	19	5,852	200
Darnell JE (1930)	9,091	83	1,654	11	7,437	72
Henle G (1912)	5,261	93	1,740	14	3,521	79

Figure 1. The 300 most-cited authors, 1961-1976.

Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Microbiology & Virology (continued)						
Henle W (1910)	4,908	100	1,024	23	3,884	77
Hilleman MR (1919)	4,871	180	713	37	4,158	143
Huebner RJ (1914)	8,418	237	2,319	16	6,099	221
Koprowski H (1916)	4,419	195	797	17	3,622	178
McCarthy BJ (1934)	4,625	102	1,176	23	3,449	79
Melnick JL (1914)	7,466	341	868	54	6,598	287
Rapp F (1929)	3,729	174	1,299	52	2,430	122
Rapp HJ (1923)	3,762	118	325	11	3,437	107
Rowe WP (1926)	7,183	130	1,344	27	5,839	103
Sever JL (1932)	4,599	179	2,350	48	2,249	131
Spiegelman S (1914)	9,712	149	1,233	26	8,479	123
Strominger JL (1925)	5,854	212	567	15	5,287	197
Uhr JW (1927)	4,567	110	1,904	23	2,663	87
Yanofsky C (1925)	4,640	145	937	19	3,703	126
Physics & Biophysics						
*Anderson PW (1923)	3,838	77	2,750	45	1,088	32
*Chance B (1913)	7,981	320	4,370	150	3,611	170
*Cromer DT (1923)	5,587	48	4,910	21	677	27
*Dalgarno A (1928)	3,712	186	1,831	77	1,881	109
*Fisher ME (1931)	5,164	109	3,509	63	1,655	46
Franklin RM (1930)	3,917	89	802	19	3,115	70
*Gell-Mann M (1929)	4,912	23	3,902	15	1,010	8
Mandel P (1942)	3,881	395	418	43	3,463	352
*McConnell HM (1927)	4,309	103	391	19	3,918	84
Miledi R (1927)	4,111	93	1,339	31	2,772	62
Osborn M (1940)	6,618	21	199	7	6,419	14
Rice SA (1932)	4,034	189	312	13	3,722	176
Setlow RB (1921)	3,777	74	2,166	25	1,611	49
Sinsheimer RL (1920)	5,332	132	183	8	5,149	124
Till JE (1931)	5,109	92	1,600	17	3,509	75
*Weber K (1936)	8,517	98	6,784	35	1,733	63
*Weinberg S (1933)	7,349	85	5,467	57	1,882	28
Wyman J (1901)	4,208	91	288	12	3,920	79
Histology & Oncology						
Boyse EA (1923)	8,239	169	1,424	25	6,815	144
Carbone PP (1931)	4,413	136	697	20	3,716	116
*Falck B (1927)	4,088	101	1,934	29	2,154	72
Heidelberger C (1920)	3,981	145	691	21	3,290	124
Hellstrom I (1932)	5,219	100	3,482	56	1,737	44
Hellstrom KE (1934)	4,985	101	811	21	4,174	80
Hokfelt T (1940)	4,553	127	1,592	53	2,961	74
Klein E (1925)	4,650	239	1,268	80	3,382	159
*Klein G (1925)	7,393	300	2,808	93	4,585	207
*Luft JH (1927)	8,902	21	8,446	12	456	9
Moore GE (1920)	4,026	247	1,746	101	2,280	146

Figure 1. The 300 most-cited authors, 1961-1976.

Author (Birthdate)	Total Citations	Total Papers	Citations as 1st Author	1st Author Papers	Citations as Co-Author	Co-Author Papers
Histology & Oncology (continued)						
Old LJ (1933)	8,457	146	2,614	24	5,843	122
*Pearse AGE (1916)	4,415	173	1,746	44	2,669	129
Todaro GJ (1937)	6,936	135	2,466	37	4,470	98
*Weber G (1932)	4,744	272	2,463	125	2,281	147
Pathology						
Benditt EP (1916)	3,755	117	317	22	3,438	95
Bensch K (1928)	3,775	19	164	4	3,611	15
Dixon FJ (1920)	6,590	169	1,163	23	5,427	146
Edwards JE (1911)	3,828	270	234	18	3,594	252
Fasman GD (1925)	4,149	98	951	21	3,198	77
*Karnovsky MJ (1926)	10,114	116	4,601	17	5,513	99
Metcalf D (1929)	3,904	130	1,750	78	2,154	52
*Miller JFA (1931)	4,432	54	2,346	32	2,086	22
*Novikoff AB (1913)	5,101	91	2,841	48	2,260	43
Popper H (1903)	3,795	168	788	50	3,007	118
*Reynolds ES (1928)	10,453	46	10,078	30	375	16
Trump BF (1932)	3,973	152	1,963	41	2,010	111
Weiss L (1928)	4,072	254	2,326	149	1,746	105
Miscellaneous Medical Disciplines (Cardiology, Hematology, Gastroenterology & Radiology)						
*Beutler E (1928)	4,537	239	3,117	133	1,420	106
*Braunwald E (1929)	15,040	422	2,255	68	12,785	354
Epstein SE (1935)	3,948	198	1,157	35	2,791	163
Frei E (1924)	4,167	173	861	46	3,306	127
Freireich EJ (1927)	3,998	179	417	14	3,581	165
Gorlin R (1926)	5,697	227	732	26	4,965	201
Grossman MI (1919)	6,096	236	864	57	5,232	179
*Herbert V (1927)	5,739	169	3,107	70	2,632	99
Hofmann AF (1931)	4,254	154	2,127	36	2,127	118
Isselbacher KJ (1925)	5,027	202	1,024	19	4,003	183
Kaplan HS (1918)	4,187	170	1,415	51	2,772	119
Lees RS (1934)	5,667	61	803	19	4,864	42
Levy RI (1937)	8,227	156	814	31	7,413	125
Lieber CS (1931)	4,432	154	2,039	59	2,393	95
Mason DT (1932)	4,232	311	1,534	59	2,698	252
Morrow AG (1922)	5,308	239	587	32	4,721	207
Mustard JF (1927)	4,852	198	1,668	53	3,184	145
Ross J (1928)	7,207	220	1,337	38	5,870	182
Sherlock S (1918)	5,421	243	931	51	4,490	192
Sonnenblick EH (1932)	8,540	237	2,800	44	5,740	193
Wagner HN (1927)	4,951	288	1,200	38	3,751	250
Wallach DFH (1926)	3,835	102	1,104	34	2,731	68

lists are not fully comparable, it would be rash to attribute this relatively small number solely to the effect of co-author citation data. It would have been interesting to produce a directly comparable list, but that will not be possible until we go back to compile source data for pre-1961 material.

In Figure 1, the authors are listed alphabetically under their disciplines. The alphabetical ordering is intended to avoid the connotation that absolute frequency of citation indicates the greater or lesser merit of an author's work. The grouping by discipline will obviate invidious comparisons across disciplines.

Each author's discipline was identified by checking a number of biographical indexes, including *American Men & Women of Science* and *World Who's Who in Science*. However, many of the authors are involved in interdisciplinary work. Thus, some may feel that they have been slightly misclassified.

The representation within disciplines is of course related to citation practices in various fields. Thus, the number of authors in a field like biochemistry, which now averages 30 references per article, is expected to be significantly higher than that for physics, where papers have an average of 12.5 citations.[5]

While the bio-medical disciplines dominate the list overall, the two largest groups are organic and inorganic chemistry and biochemistry, each with 14% of the total. Of the 42 authors in chemistry, 29 are organic chemists and 13 are inorganic chemists. Immunology is represented by 26 authors (8.7%); endocrinology by 24 (8.0%).

Molecular biology and pharmacology, with 21 authors apiece, each account for 7.0% of the total. Physiology and cell biology are both represented by 19 authors (6.3%); physics and biophysics by 18 (6.0%). There are also nine microbiologists and nine virologists on the list, who together account for 6.0% of the total. Pathology is represented by 13 (4.3%) authors, oncology by ten (3.3%), and cardiology also by ten.

Five authors (1.7%) are in gastroenterology. And another five are in histology. Hematology is represented by four authors (1.3%). And there are three radiologists (1.0%).

No mathematicians *per se* appear on the list. However, M.E. Fisher, a mathematical physicist, is in the top 300. Engineers do not appear on the list either. This may be due to the fact that engineering and technology papers average only 6 citations and tend to cite handbooks and textbooks rather than engineering papers.[6]

In the past it was claimed by Dr. Robert S. Platt, Jr., of the Department of Botany, Ohio State University, that botanists were particularly slighted by the first-author phenomenon.[7] Yet no botanists appeared on this "all-author" list. The most-cited botanist is F. Skoog, who ranked 489th with 3,141 citations. The absence of botanists in

the top 300 can be attributed to many causes. Dr. L. Andrew Staehelin of the University of Colorado, Boulder has suggested that many botanists call themselves molecular or cell biologists these days.[8]

J. Levitt of the Carnegie Institution of Washington points out that botanists cite the life and physical sciences literature, but that the reverse is not true for chemists and other basic scientists.[9] This would suggest that botany is primarily descriptive and applied, and is no longer a "basic" science.

In any case, it is certain that the lack of representation on this list of some scientific disciplines and specialties is an artifact of the activity and citation practices in the missing fields, as well as of the limits on the length of the list we could publish. We may expand the most-cited "all-author" list to 1,000 or more names in the future. Hopefully, the most-cited authors in all specialties would be represented—even botany, earth sciences, and other poorly represented fields.

In Figure 1, we have also shown the total number of citations received and the total number of papers written by each author, 1961-1976. Following this is a breakdown of the citations to papers on which the person was the primary author, the number of papers on which the person was the primary author, citations to co-authored papers, and the number of papers on which the person was co-author.

These data give a more accurate picture of the accomplishments of many authors. For example, Carl Djerassi would have ranked in the top 200 authors if we had only counted citations to publications on which he was primary author. When the papers he co-authored are taken into account, he ranks as the *sixth* most-cited author.

The reason for this great discrepancy is simple. Between 1961 and 1976, he was first author of 77 papers. However, he was a co-author on 354 papers.

Anyone familiar with the work of this genius, who helped develop the first successful birth-control pill, knows that this citation record accurately reflects his formidable impact on science during the past few decades—no less than his remarkable and continuing productivity.

An even more extreme example is Nobelist H.G. Khorana. By primary-author count alone, he would not have ranked in the top 2,000 authors. But the inclusion of citations to papers he co-authored puts him into the top 300.

Every author on this list has been cited at least 3,700 times. The average number of citations is 5,496. The average number of citations for primary-authored papers is 1,794; for co-authored papers, 3,791. Incidentally, there are another 1,150 authors who were cited 2,000 or more times in this period.

In Figure 1, the year of birth of each author appears in parentheses after the name. A few authors are deceased. The average age is 54.

It is not surprising that only one author, F. Lipmann, was born before 1900. The citation counts on which this study is based are only to papers published, 1961-1976. Only 4% (12) of the authors were born 1900-1909; 21% (63), 1910-1919. Almost half (142) were born in the 1920's and one fourth in the 30's. Of the five authors born in the 40's, M.D. Cooper (1945) appears to be the youngest.

Some readers may criticize the methodology adopted here. After all, if ten people co-author one paper, why should each author be treated equally with those who have written a paper alone? I think the data will show that "junior" technicians and authors rank poorly unless they have consistently co-authored papers with a senior author like Khorana. For example, none of Djerassi's co-authors appears on this list. Khorana's three co-authors on the list—Kornberg, Racker, and Roseman—were all professors at the time they authored papers with him. Roseman, for example, was a "visiting professor" when he and Khorana worked together.[10]

The present list does include some scientist-administrators who are inclined to place their names on hundreds of papers, as secondary authors. The list may also include certain academicians, who have not achieved great distinction but have co-authored dozens of papers with graduate students. I have observed that long series of papers by such "groups" tend to be displaced by "review" papers written by the "senior" scientists on the team. That's why first-author data identified so many scientists who had also been secondary authors on many papers.

As always, we have tried to avoid errors due to homographs (names which represent more than one person). While these were not difficult to detect, it was not easy to separate the publications of each person involved. In some cases, homographs were removed from our original list because none of the people had 3,700 or more citations. In others, one of the persons did have enough citations to remain in the top 300. We have adjusted the number of citations and papers attributed to him or her. A good example of our method is E. Klein, which proved to be a homograph representing several scientists: Edmund Klein, Eva Klein, Elias Klein, and others. We separated the citations belonging to each and discovered that Eva Klein was the only one who had enough citations to remain on the list. We then adjusted the number of citations and papers attributed to her.

For the majority of authors, however, the figures were not changed. Some of the authors who scan the list may find a few more papers attributed to them than they wrote. We considered homographs with just a few papers and citations insignificant "noise."

Now that we have compiled this all-author file, we can better study patterns of self-citation. Indeed, we are in a position to measure degrees of "incestuous citation," or citation

among teams of researchers. Previously, with only first-author data available, a person's self-citations could only be identified when the person was the *first* author of a cited work. Now we can identify citations to publications on which a person was a co-author. We might use this new capability to explore the inbreeding patterns of certain groups who tend to cite each other. Indeed, such incestuous citation might be characteristic of some milestone developments. If such enclaves exist, we need to know more about them, and why they remain isolated.

Now that we have begun to compile this kind of information, we will need to produce new reports every year or two, eliminating as we go the oldest years of our data. This will reduce the rankings of those scientists who published high-impact works in earlier years.

As each year passes, our data will become ever more comprehensive, because of the rapid growth of the *SCI* files in the sixties. I would expect, therefore, that our future studies will be more comprehensive and accurate than the present one.

As always, your comments are invited. If you think we have made an error, please do not hesitate to contact us. From our earlier experience, we have reason to expect correction notes from a few authors.

As we have done in the past, we will soon publish a list of each author's most-cited work, as well as academy memberships and awards.

ERRATUM:
During the computer run for the 300 authors list, a few names which should have been on the list were not picked up. I apologize to W.C. Hamilton and G.R. Satchler for their omission from the list. The computer problem has now been corrected, and these scientists will appear in our upcoming study of the 1,000 most-cited authors.

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