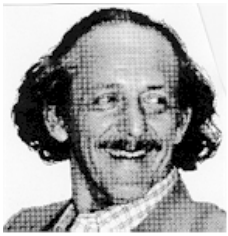

Current Comments

The 1979 Articles Most Cited from 1979 to 1981. 1. Life Sciences

Number 26 June 28, 1982

This is the latest in an ongoing series of essays that identify articles which became highly cited shortly after publication. Papers that receive an immediate burst of citations often represent the "hot spots" of science—areas of inquiry that are presently of special interest to researchers. The previous two essays in this series identified the 1978 papers that were highly cited in 1978-1979.[1,2] This essay presents the life sciences papers of 1979 that were highly cited in 1979-1980. Also listed are 1979 papers that would have been included if we had considered 1981 citations as well. The second part of this essay will cover the physical sciences.

The 102 papers in this study are listed in Figure 1, which, in addition to 1979-1980 citations, lists 1981 citations as well. As before, the articles are segregated by subject area, and then listed alphabetically by first author. We hope this arrangement will discourage invidious comparisons. All of the papers in Figure 1 are undoubtedly interesting, but many more 1979 papers not included here will eventually become highly cited. What makes this group particularly interesting is the immediacy of their impact on the scientific community.

Of the 4,000,000 papers or books cited in *Science Citation Index*® (*SCI*®) each year, most receive one or two citations in a two-year period. By comparison, the average paper in this study received 60 citations—nine in 1979, and 51 in 1980. The most-cited paper received 192 citations, while the least-cited had 45.

A new feature of this study is the inclusion of research front data. In previous essays,[3] I have explained ISI®'s clustering technique for identifying new research fronts. Each cluster is associated with a group of co-cited core papers. The research front is the group of current papers that cite one or more core papers in the cluster. Co-citation clustering is the basis for "research front searching," available through our online *ISI/BIOMED*™ system.[4]

In Figure 1, where applicable, we have identified the *ISI/BIOMED* research fronts with which each paper is associated. The names of the research fronts themselves can be found in the *Index to Research Fronts in ISI/BIOMED*.[5] The very fact that nearly all of these papers turned out to be core papers in 1980 or 1981 research fronts in *ISI/BIOMED* is interesting in itself, because it demonstrates that the system has dynamically responded to any paradigm changes these advances may represent. In all, 121 research fronts are represented in Figure 1 and in the supplementary list of papers in Figure 2. We have listed in Table 1 names of those research fronts whose core papers include two or more papers in this study.

All of the papers in Figure 1 received many more citations than the minimum threshold of 12 used for inclusion in an

Figure 1: The 1979 life sciences articles most cited in 1979-1980. The authors' addresses follow each citation, as do the code numbers of the *ISI/BIOMED*™ research front specialties for which these are core papers.

Molecular Genetics—Nucleic Acid Structure

79	80	79 & 80 Total Citations	81	
1	44	45	55	**Barrell B G, Bankier A T & Drouin J.** A different genetic code in human mitochondria. *Nature* 282:189-94, 1979. MRC Lab. Mol. Biol., Cambridge, UK. 80-0105; 81-0140.
7	43	50	71	**Cameron J R, Loh E Y & Davis R W.** Evidence for transposition of dispersed repetitive DNA families in yeast. *Cell* 16:739-51, 1979. Stanford Univ., Sch. Med., Stanford, CA. 80-0173; 81-0190.
27	82	109	59	**Gannon F, O'Hare K, Perrin F, LePennec J P, Benoist C, Cochet M, Breathnach R, Royal A, Garapin A, Cami B & Chambon P.** Organisation and sequences at the 5' end of a cloned complete ovalbumin gene. *Nature* 278:428-34, 1979. CNRS, Inst. Chim. Biol., Strasbourg, France; CNRS, Inst. Pasteur, Paris, France.
16	48	64	13	**Gauss D H, Grüter F & Sprinzl M.** Compilation of tRNA sequences. *Nucl. Acid. Res.* 6:R1-R19, 1979. Max Planck Inst., Dept. Chem., Göttingen, FRG.
11	38	49	13	**Hensgens L A M, Grivell L A, Borst P & Bos J L.** Nucleotide sequence of the mitochondrial structural gene for subunit 9 of yeast ATPase complex. *Proc. Nat. Acad. Sci. US* 76:1663-7, 1979. Univ. Amsterdam, Jan Swammerdam Inst., Amsterdam, the Netherlands. 80-0105; 81-0140.
2	50	52	62	**Lomedico P, Rosenthal N, Efstratiadis A, Gilbert W, Kolodner R & Tizard R.** The structure and evolution of the two nonallelic rat preproinsulin genes. *Cell* 18:545-58, 1979. Harvard Univ., Biol. Labs. & Sch. Med., Cambridge; Sidney Farber Cancer Inst., Boston, MA. 80-0518; 81-1322.
28	164	192	115	**Nakanishi S, Inoue A, Kita T, Nakamura M, Chang A C Y, Cohen S N & Numa S.** Nucleotide sequence of cloned cDNA for bovine corticotropin-β-lipotropin precursor. *Nature* 278:423-7, 1979. Kyoto Univ., Dept. Med. Chem., Kyoto, Japan; Stanford Univ., Sch. Med., Stanford, CA. 80-1519; 81-1204.
4	44	48	77	**Peattie D A.** Direct chemical method for sequencing RNA. *Proc. Nat. Acad. Sci. US* 76:1760-4, 1979. Harvard Univ., Dept. Biochem. Mol. Biol., Cambridge, MA. 80-1440.
15	43	58	43	**Post L E, Strycharz G D, Nomura M, Lewis H & Dennis P P.** Nucleotide sequence of the ribosomal protein gene cluster adjacent to the gene for RNA polymerase subunit β in *Escherichia coli*. *Proc. Nat. Acad. Sci. US* 76:1697-701, 1979. Univ. Wisconsin, Inst. Enzyme Res., Madison, WI; Univ. British Columbia, Dept. Med., Vancouver, BC, Canada. 80-1379.
6	42	48	60	**Potter S S, Brorein W J, Dunsmuir P & Rubin G M.** Transposition of elements of *412*, *copia* and *297* dispersed repeated gene families in Drosophila. *Cell* 17:415-27, 1979. Sidney Farber Cancer Inst., Dept. Tumor Biol.; Harvard Univ., Sch. Med., Boston, MA. 80-0173; 81-0190.
0	47	47	148	**Rosenberg M & Court D.** Regulatory sequences involved in the promotion and termination of RNA transcription. *Annu. Rev. Genet.* 13:319-53, 1979. NCI, NIH, Bethesda, MD.
5	45	50	35	**Seif I, Khoury G & Dhar R.** BKV splice sequences based on analysis of preferred donor and acceptor sites. *Nucl. Acid. Res.* 6:3387-98, 1979. NCI, NIH, Bethesda, MD. 80-0815.
5	111	116	245	**Wahl G M, Stern M & Stark G R.** Efficient transfer of large DNA fragments from agarose gels to diazobenzyloxyethyl-paper and rapid hybridization by using dextran sulfate. *Proc. Nat. Acad. Sci. US* 76:3683-7, 1979. Stanford Univ., Sch. Med., Stanford, CA.
0	52	52	117	**Wang A H J, Quigley G J, Kolpak F J, Crawford J L, van Boom J H, van der Marel G & Rich A.** Molecular structure of a left-handed double helical DNA fragment at atomic resolution. *Nature* 282:680-6, 1979. Mass. Inst. Technol., Dept. Biol., Cambridge, MA; Univ. Leiden, Gorlaeus Labs., the Netherlands. 80-0265; 81-0287.

Molecular Genetics—General Gene Expression, Regulation

79	80	79 & 80 Total Citations	81	
3	42	45	70	**Ashburner M & Bonner J J.** The induction of gene activity in Drosophila by heat shock. *Cell* 17:241-54, 1979. Univ. Calif., Dept. Biochem. Biophys., San Francisco, CA. 80-0282; 81-0294.
21	81	102	60	**Crick F.** Split genes and RNA splicing. *Science* 204:264-71, 1979. Salk Inst. Biol. Studies, La Jolla, CA. 80-1266.
6	73	79	67	**Davidson E H & Britten R J.** Regulation of gene expression: possible role of repetitive sequences. *Science* 204:1052-9, 1979. Calif. Inst. Technol., Div. Biol., Pasadena, CA.
9	38	47	36	**Gilboa E, Goff S, Shields A, Yoshimura F, Mitra S & Baltimore D.** In vitro synthesis of a 9 Kbp terminally redundant DNA carrying the infectivity of Moloney murine leukemia virus. *Cell* 16:863-74, 1979. Mass. Inst. Technol., Dept. Biol. & Ctr. Cancer Res., Cambridge, MA. 80-0560; 81-0190.
11	35	46	25	**Goeddel D V, Kleid D G, Bolivar F, Heyneker H L, Yansura D G, Crea R, Hirose T, Kraszewski A, Itakura K & Riggs A D.** Expression in *Escherichia coli* of chemically synthesized genes for human insulin. *Proc. Nat. Acad. Sci. US* 76:106-10, 1979. Genentech, Inc., San Francisco, CA; City of Hope Nat. Med. Ctr., Div. Biol., Duarte, CA. 80-1804; 81-1940.
3	42	45	76	**Hanawalt P C, Cooper P K, Ganesan A K & Smith C A.** DNA repair in bacteria and mammalian cells. *Annu. Rev. Biochem.* 48:783-836, 1979. Stanford Univ., Dept. Biol. Sci., Stanford, CA.
8	44	52	44	**Struhl K, Stinchcomb D T, Scherer S & Davis R W.** High-frequency transformation of yeast: autonomous replication of hybrid DNA molecules. *Proc. Nat. Acad. Sci. US* 76:1035-9, 1979. Stanford Univ., Sch. Med., Stanford, CA. 80-0510; 81-0543.
11	34	45	51	**Weinstock G M, McEntee K & Lehman I R.** ATP-dependent renaturation of DNA catalyzed by the recA protein of *Escherichia coli*. *Proc. Nat. Acad. Sci. US* 76:126-30, 1979. Stanford Univ., Sch. Med., Stanford, CA. 80-1036; 81-0108.
5	67	72	60	**Wigler M, Sweet R, Sim G K, Wold B, Pellicer A, Lacy E, Maniatis T, Silverstein S & Axel R.** Transformation of mammalian cells with genes from procaryotes and eucaryotes. *Cell* 16:777-85, 1979. Columbia Univ., Coll. Phys. Surg., New York, NY. 80-0341; 81-0366.

Molecular Genetics—Globin Gene Expression

9	50	59	45	**Fritsch E F, Lawn R M & Maniatis T.** Characterisation of deletions which affect the expression of fetal globin genes in man. *Nature* 279:598-603, 1979. Calif. Inst. Technol., Div. Biol., Pasadena, CA. 80-0359; 81-0428.
2	56	58	53	**Konkel D A, Maizel J V & Leder P.** The evolution and sequence comparison of two recently diverged mouse chromosomal β-globin genes. *Cell* 18:865-73, 1979. NICHHD, NIH, Bethesda, MD. 80-0359; 81-2464.
27	46	73	18	**Little P F R, Flavell R A, Kooter J M, Annison G & Williamson R.** Structure of the human fetal globin gene locus. *Nature* 278:227-31, 1979. Univ. London, St. Mary's Hosp. Med. Sch., London, UK; Univ. Amsterdam, Lab. Biochem., Amsterdam, the Netherlands. 80-0359; 81-0428.
7	49	56	35	**Mulligan R C, Howard B H & Berg P.** Synthesis of rabbit β-globin in cultured monkey kidney cells following infection with a SV 40 β-globin recombinant genome. *Nature* 277:108-14, 1979. Stanford Univ., Med. Ctr., Stanford, CA. 80-0341; 81-2073.
1	50	51	52	**Nishioka Y & Leder P.** The complete sequence of a chromosomal mouse α-globin gene reveals elements conserved throughout vertebrate evolution. *Cell* 18:875-82, 1979. NICHHD, NIH, Bethesda, MD. 80-0359; 81-2464.

79	80	79 & 80 Total Citations	81	
8	45	53	25	**Orkin S H, Old J, Lazarus H, Altay C, Gurgey A, Weatherall D J & Nathan D G.** The molecular basis of α-thalassemias: frequent occurrence of dysfunctional α loci among non-Asians with Hb H disease. *Cell* 17:33-42, 1979. Children's Hosp. Med. Ctr.; Sidney Farber Cancer Inst.; Harvard Univ., Sch. Med., Boston, MA; Univ. Oxford, Nuffield Dept. Clin. Med., Oxford, UK; Hacettepe Univ., Children's Hosp. Med. Ctr., Ankara, Turkey. 80-0359; 81-1565.
9	44	53	35	**Weatherall D J & Clegg J B.** Recent developments in the molecular genetics of human hemoglobin. *Cell* 16:467-79, 1979. Univ. Oxford, Nuffield Dept. Clin. Med., Oxford, UK. 80-0359.
12	44	56	44	**Weisbrod S & Weintraub H.** Isolation of a subclass of nuclear proteins responsible for conferring a DNase I-sensitive structure on globin chromatin. *Proc. Nat. Acad. Sci. US* 76:630-4, 1979. Princeton Univ., Dept. Biochem. Sci., Princeton, NJ. 80-0522; 81-0112.

Neuroendocrinology/Neurophysiology

6	39	45	32	**Asano T & Spector S.** Identification of inosine and hypoxanthine as endogenous ligands for the brain benzodiazepine-binding sites. *Proc. Nat. Acad. Sci. US* 76:977-81, 1979. Roche Inst. Mol. Biol., Nutley, NJ. 80-0275; 81-0301.
5	55	60	81	**Chang K J & Cuatrecasas P.** Multiple opiate receptors. *J. Biol. Chem.* 254:2610-8, 1979. Wellcome Res. Labs., Dept. Mol. Biol., Research Triangle Park, NC. 80-1068; 81-1142.
4	45	49	48	**DeLorenzo R J, Freedman S D, Yohe W B & Maurer S C.** Stimulation of Ca^{2+}-dependent neurotransmitter release and presynaptic nerve terminal protein phosphorylation by calmodulin and a calmodulin-like protein isolated from synaptic vesicles. *Proc. Nat. Acad. Sci. US* 76:1838-42, 1979. Yale Univ., Sch. Med., New Haven, CT. 80-0045; 81-0046.
5	42	47	57	**Heuser J E, Reese T S, Dennis M J, Jan Y, Jan L & Evans L.** Synaptic vesicle exocytosis captured by quick freezing and correlated with quantal transmitter release. *J. Cell Biol.* 81:275-300, 1979. Univ. Calif., Sch. Med., San Francisco, CA; NINCDS, NIH, Bethesda, MD. 81-1347.
11	59	70	66	**Hirata F, Strittmatter W J & Axelrod J.** β-adrenergic receptor agonists increase phospholipid methylation, membrane fluidity, and β-adrenergic receptor-adenylate cyclase coupling. *Proc. Nat. Acad. Sci. US* 76:368-72, 1979. NIMH, NIH, Bethesda, MD. 80-0818; 81-0878.
8	44	52	32	**Innis R B, Corrêa F M A, Uhl G R, Schneider B & Snyder S H.** Cholecystokinin octapeptide-like immunoreactivity: histochemical localization in rat brain. *Proc. Nat. Acad. Sci. US* 76:521-5, 1979. Johns Hopkins Univ., Sch. Med., Baltimore, MD; Rockefeller Univ. Hosp., New York, NY. 80-1076; 81-0246.
28	139	167	140	**Kebabian J W & Calne D B.** Multiple receptors for dopamine. *Nature* 277:93-6, 1979. NINCDS, NIH, Bethesda, MD.
5	41	46	52	**Larsson L I & Rehfeld J F.** Localization and molecular heterogeneity of cholecystokinin in the central and peripheral nervous system. *Brain Res.* 165:201-18, 1979. Univ. Aarhus, Inst. Med. Biochem., Aarhus, Denmark. 80-1076; 81-0246.
4	45	49	48	**Meites J, Bruni J F, Van Vugt D A & Smith A F.** Relation of endogenous opioid peptides and morphine to neuroendocrine functions. *Life Sci.* 24:1325-36, 1979. Michigan State Univ., Dept. Physiol., East Lansing, MI. 81-0722.
12	38	50	24	**Neubig R R, Krodel E K, Boyd N D & Cohen J B.** Acetylcholine and local anesthetic binding to *Torpedo* nicotinic postsynaptic membranes after removal of nonreceptor peptides. *Proc. Nat. Acad. Sci. US* 76:690-4, 1979. Harvard Univ., Sch. Med., Boston, MA. 80-0008; 81-1141.

79	80	79 & 80 Total Citations	81	
8	37	45	32	**Pickel V M, Joh T H, Reis D J, Leeman S E & Miller R J.** Electron microscope localization of substance-P and enkephalin in axon terminals related to dendrites of catecholaminergic neurons. *Brain Res.* 160:387-400, 1979. Cornell Univ. Med. Coll., Dept. Neurol., New York; Harvard Univ., Sch. Med., Boston, MA; Univ. Chicago, Dept. Pharmacol. & Physiol. Serv., Chicago, IL.
9	38	47	32	**Rossier J, Battenberg E, Pittman Q, Bayon A, Koda L, Miller R, Guillemin R & Bloom F.** Hypothalamic enkephalin neurones may regulate the neurohypophysis. *Nature* 277:653-5, 1979. Salk Inst. Biol. Studies, La Jolla, CA. 80-0653.
9	45	54	46	**U'Prichard D C & Snyder S H.** Distinct α-noradrenergic receptors differentiated by binding and physiological relationships. *Life Sci.* 24:79-88, 1979. Johns Hopkins Univ., Sch. Med., Baltimore, MD. 80-2760; 81-0067.

Virology

13	37	50	21	**Andersson P, Goldfarb M P & Weinberg R A.** A defined subgenomic fragment of in vitro synthesized Moloney sarcoma virus DNA can induce cell transformation upon transfection. *Cell* 16:63-75, 1979. Mass. Inst. Technol., Ctr. Cancer Res. & Dept. Biol., Cambridge, MA. 80-0019; 81-0223.
10	42	52	30	**Hayman M J, Royer-Pokora B & Graf T.** Defectiveness of avian erythroblastosis virus: synthesis of a 75K *gag*-related protein. *Virology* 92:31-45, 1979. Imperial Cancer Res. Fund, Dept. Tumour Biol., London, UK; Max Planck Inst. Virus Res., Dept. Biol. Med., Tübingen, FRG. 80-0614; 81-0018.
7	51	58	39	**Lane D P & Crawford L V.** T antigen is bound to a host protein in SV 40-transformed cells. *Nature* 278:261-3, 1979. Imperial Coll., Dept. Zool.; Imperial Cancer Res. Fund, Dept. Mol. Virol., London, UK. 80-0027; 81-0817.
4	41	45	41	**Linzer D I H & Levine A J.** Characterization of a 54K dalton cellular SV40 tumor antigen present in SV40-transformed cells and uninfected embryonal carcinoma cells. *Cell* 17:43-52, 1979. Princeton Univ., Dept. Biochem. Sci., Princeton, NJ. 80-0027; 81-0817.
11	61	72	43	**Oppermann H, Levinson A D, Varmus H E, Levintow L & Bishop J M.** Uninfected vertebrate cells contain a protein that is closely related to the product of the avian sarcoma virus transforming gene (src). *Proc. Nat. Acad. Sci. US* 76:1804-8, 1979. Univ. Calif., Dept. Microbiol. Immunol., San Francisco, CA. 80-0019; 81-0018.
8	43	51	22	**Rübsamen H, Friis R R & Bauer H.** *src* gene product from different strains of avian sarcoma virus: kinetics and possible mechanism of heat inactivation of protein kinase activity from cells infected by transformation-defective, temperature-sensitive mutant and wild-type virus. *Proc. Nat. Acad. Sci. US* 76:967-71, 1979. Justus Liebig Univ., Inst. Virol., Giessen, FRG. 80-0019; 81-0018.
12	59	71	41	**Sabran J L, Hsu T W, Yeater C, Kaji A, Mason W S & Taylor J M.** Analysis of integrated avian RNA tumor virus DNA in transformed chicken, duck, and quail fibroblasts. *J. Virol.* 29:170-8, 1979. Univ. Pennsylvania, Dept. Microbiol.; Fox Chase Cancer Ctr., Inst. Cancer Res., Phila., PA. 80-0560; 81-0190.
4	58	62	79	**Shapiro J A.** Molecular model for the transposition and replication of bacteriophage Mu and other transposable elements. *Proc. Nat. Acad. Sci. US* 76:1933-7, 1979. Univ. Chicago, Dept. Microbiol., Chicago, IL. 80-0271; 81-0295.
11	42	53	13	**Soeda E, Arrand J R, Smolar N & Griffin B E.** Sequence from early region of polyoma virus DNA containing viral replication origin and encoding small, middle and (part of) large T antigens. *Cell* 17:357-70, 1979. Imperial Cancer Res. Fund, London, UK. 80-0027; 81-1470.
12	33	45	24	**Takahashi K, Akahane Y, Gotanda T, Mishiro T, Imai M, Miyakawa Y & Mayumi M.** Demonstration of hepatitis B e antigen in the core of Dane particles. *J. Immunol.* 122:275-9, 1979. Jichi Med. Sch., Immunol. Div., Tochigi-ken; Tokyo Metropolitan Inst. Med. Sci., Hepatitis Div.; Univ. Tokyo, Third Dept. Internal Med., Tokyo, Japan. 81-0145.

79	80	79 & 80 Total Citations	81	
7	40	47	21	**Tjian R & Robbins A.** Enzymatic activities associated with a purified simian virus 40 T antigen-related protein. *Proc. Nat. Acad. Sci. US* 76:610-4, 1979. Cold Spring Harbor Lab., Cold Spring Harbor, NY. 80-0019; 81-0018.

Immunology

14	53	67	61	**Djeu J Y, Heinbaugh J A, Holden H T & Herberman R B.** Augmentation of mouse natural killer cell activity by interferon and interferon inducers. *J. Immunol.* 122:175-81, 1979. Litton Bionetics, Inc., Kensington, MD; NCI, NIH, Bethesda, MD. 80-1428; 81-1538.
14	35	49	26	**Germain R N, Ju S T, Kipps T J, Benacerraf B & Dorf M E.** Shared idiotypic determinants on antibodies and T-cell derived suppressor factor specific for the random terpolymer L-glutamic acid^{60}-L-alanine^{30}-L-tyrosine^{10}. *J. Exp. Med.* 149:613-22, 1979. Harvard Univ., Sch. Med., Boston, MA. 80-0001; 81-0059.
10	46	56	41	**Herberman R B, Ortaldo J R & Bonnard G D.** Augmentation by interferon of human natural and antibody-dependent cell-mediated cytotoxicity. *Nature* 277:221-3, 1979. NCI, NIH, Bethesda, MD. 80-1428.
8	49	57	81	**Herberman R B, Djeu J Y, Kay H D, Ortaldo J R, Riccardi C, Bonnard G D, Holden H T, Fagnani R, Santoni A & Puccetti P.** Natural killer cells: characteristics and regulation of activity. *Immunol. Rev.* 44:43-70, 1979. NCI, NIH, Lab. Immunodiagnosis, Bethesda, MD; Litton Bionetics, Inc., Kensington, MD; Univ. Perugia, Inst. Pharmacol., Perugia, Italy. 80-2023.
5	40	45	58	**Kiessling R & Wigzell H.** An analysis of the murine NK cell as to structure, function and biological relevance. *Immunol. Rev.* 44:165-208, 1979. Karolinska Inst., Dept. Tumor Biol., Stockholm, Sweden; Uppsala Univ., Biomed. Ctr., Uppsala, Sweden. 80-2023.
4	47	51	58	**McMichael A J, Pilch J R, Galfré G, Mason D Y, Fabre J W & Milstein C.** A human thymocyte antigen defined by a hybrid myeloma monoclonal antibody. *Eur. J. Immunol.* 9:205-10, 1979. Univ. Oxford, Nuffield Dept. Surg. & Dept. Pathol., Radcliffe Infirm., Oxford, UK; MRC Mol. Biol. Lab., Cambridge, UK. 81-2489.
19	87	106	82	**Nathan C F, Brukner L H, Silverstein S C & Cohn Z A.** Extracellular cytolysis by activated macrophages and granulocytes. *J. Exp. Med.* 149:84-99; 100-13, 1979. Rockefeller Univ., New York, NY. 80-2182; 81-0033.
1	46	47	120	**Reinherz E L, Kung P C, Goldstein G & Schlossman S F.** Separation of functional subsets of human T cells by a monoclonal antibody. *Proc. Nat. Acad. Sci. US* 76:4061-5, 1979. Harvard Univ., Sch. Med.; Sidney Farber Cancer Inst., Boston, MA; Ortho Pharmaceutical Corp., Div. Immunosci., Raritan, NJ. 80-1573; 81-2489.
9	42	51	51	**Reinherz E L, Parkman R, Rappeport J, Rosen F S & Schlossman S F.** Aberrations of suppressor T cells in human graft-versus-host disease. *N. Engl. J. Med.* 300:1061-8, 1979. Harvard Univ., Sch. Med.; Sidney Farber Cancer Inst.; Children's Hosp. Med. Ctr.; Peter Bent Brigham Hosp., Boston, MA. 80-1573.
8	39	47	36	**Reinherz E L & Schlossman S F.** Con-A inducible suppression of MLC: evidence for mediation by the TH_2^+ T cell subset in man. *J. Immunol.* 122:1335-41, 1979. Harvard Univ., Sch. Med.; Sidney Farber Cancer Inst., Boston, MA. 80-1573.

Cancer Research—Clinical

22	47	69	29	**Antunes C M F, Stolley P D, Rosenshein N B, Davies J L, Tonascia J A, Brown C, Burnett L, Rutledge A, Pokempner M & Garcia R.** Endometrial cancer and estrogen use. *N. Engl. J. Med.* 300:9-13, 1979. Johns Hopkins Univ., Sch. Hygiene & Pub. Hlth. & Sch. Med., Baltimore, MD; Univ. Pennsylvania Sch. Med., Phila., PA; Fed. Univ. Minas Gerais, Belo Horizonte, Brazil. 80-0229; 81-0252.

79	80	79 & 80 Total Citations	81	
15	31	46	24	**Jick H, Watkins R N, Hunter J R, Dinan B J, Madsen S, Rothman K J & Walker A M.** Replacement estrogens and endometrial cancer. *N. Engl. J. Med.* 300:218-22, 1979. Boston Univ. Med. Ctr. & Harvard Univ. Sch. Pub. Hlth., Boston, MA; Grp. Hlth. Cooperative Puget Sound, Seattle, WA. 80-0229; 81-0252.
12	34	46	28	**McGregor A M, Scanlon M F, Hall K, Cook D B & Hall R.** Reduction in size of a pituitary tumor by bromocriptine therapy. *N. Engl. J. Med.* 300:291-3, 1979. Royal Victoria Infirm., Dept. Med.; Newcastle Gen. Hosp., Dept. Neuroradiol., Newcastle upon Tyne, UK. 80-2436; 81-1896.
12	39	51	77	**Stern R S, Thibodeau L A, Kleinerman R A, Parrish J A & Fitzpatrick T B.** Risk of cutaneous carcinoma in patients treated with oral methoxsalen photochemotherapy for psoriasis. *N. Engl. J. Med.* 300:809-13, 1979. Harvard Univ. Sch. Med. & Sch. Pub. Hlth.; Beth Israel Hosp., Depts. Dermatol. and Comp. Med.; Mass. Gen. Hosp., Boston, MA. 80-2447; 81-2681.

Cancer Research—Basic

7	55	62	47	**Ames B N.** Identifying environmental chemicals causing mutations and cancer. *Science* 204:587-93, 1979. Univ. Calif., Dept. Biochem., Berkeley, CA.
6	39	45	38	**Huberman E & Callaham M F.** Induction of terminal differentiation in human promyelocytic leukemia cells by tumor-promoting agents. *Proc. Nat. Acad. Sci. US* 76:1293-7, 1979. Oak Ridge Nat. Lab., Div. Biol., Oak Ridge, TN. 80-0485; 81-0750.
1	90	91	94	**Murphy R C, Hammarström S & Samuelsson B.** Leukotriene C: a slow-reacting substance from murine mastocytoma cells. *Proc. Nat. Acad. Sci. US* 76:4275-9, 1979. Karolinska Inst., Dept. Chem., Stockholm, Sweden. 80-0043; 81-0371.

Cell Biology, Biochemistry

9	41	50	72	**Borgeat P & Samuelsson B.** Arachidonic acid metabolism in polymorphonuclear leukocytes: effects of ionophore A23187. *Proc. Nat. Acad. Sci. US* 76:2148-52, 1979. Karolinska Inst., Dept. Chem., Stockholm, Sweden. 80-0043; 81-0371.
8	118	126	170	**Goldstein J L, Anderson R G W & Brown M S.** Coated pits, coated vesicles, and receptor-mediated endocytosis. *Nature* 279:679-85, 1979. Univ. Texas, Hlth. Sci. Ctr., Dallas, TX.
0	55	55	49	**Hammarström S, Murphy R C, Samuelsson B, Clark D A, Mioskowski C & Corey E J.** Structure of leukotriene-C: identification of the amino acid part. *Biochem. Biophys. Res. Commun.* 91:1266-72, 1979. Karolinska Inst., Dept. Chem., Stockholm, Sweden; Harvard Univ., Dept. Chem., Cambridge, MA. 80-0043; 81-0371.
5	74	79	123	**Krebs E G & Beavo J A.** Phosphorylation-dephosphorylation of enzymes. *Annu. Rev. Biochem.* 48:923-59, 1979. Howard Hughes Med. Inst., Lab. Mol. Pharmacol.; Univ. Washington, Dept. Pharmacol., Seattle, WA.
18	52	70	44	**Maccecchini M L, Rudin Y, Blobel G & Schatz G.** Import of proteins into mitochondria: precursor forms of the extramitochondrially made F_1-ATPase subunits in yeast. *Proc. Nat. Acad. Sci. US* 76:343-7, 1979. Univ. Basel, Dept. Biochem., Basel, Switzerland; Rockefeller Univ., New York, NY. 80-1034; 81-0257.
6	39	45	30	**Perkins M E, Ji T H & Hynes R O.** Cross-linking of fibronectin to sulfated proteoglycans at the cell surface. *Cell* 16:941-52, 1979. Mass. Inst. Technol., Dept. Biol. & Ctr. Cancer Res., Cambridge, MA; Univ. Wyoming, Dept. Biochem., Laramie, WY. 80-0107; 81-0125.

79	80	79 & 80 Total Citations	81	
11	41	52	64	**Ryan D E, Thomas P E, Korzeniowski D & Levin W.** Separation and characterization of highly purified forms of liver microsomal cytochrome P-450 from rats treated with polychlorinated biphenyls, phenobarbital, and 3-methylcholanthrene. *J. Biol. Chem.* 254:1365-74, 1979. Hoffmann-La Roche, Dept. Biochem. Drug Metab., Nutley, NJ. 80-2657; 81-0810.

Immunogenetics

13	46	59	35	**Early P W, Davis M M, Kaback D B, Davidson N & Hood L.** Immunoglobulin heavy chain gene organization in mice: analysis of a myeloma genomic clone containing variable and α constant regions. *Proc. Nat. Acad. Sci. US* 76:857-61, 1979. Calif. Inst. Technol., Div. Biol., Pasadena, CA. 80-0594; 81-0039.
20	44	64	65	**Klein J.** The major histocompatibility complex of the mouse. *Science* 203:516-21, 1979. Max Planck Inst. Biol., Tubingen, FRG.
5	73	78	77	**Max E E, Seidman J G & Leder P.** Sequences of five potential recombination sites encoded close to an immunoglobulin κ constant region gene. *Proc. Nat. Acad. Sci. US* 76:3450-4, 1979. NICHHD, NIH, Bethesda, MD. 80-0594; 81-0039.
3	87	90	94	**Sakano H, Hüppi K, Heinrich G & Tonegawa S.** Sequences at the somatic recombination sites of immunoglobulin light-chain genes. *Nature* 280:288-94, 1979. Basel Inst. Immunol., Basel, Switzerland. 80-0594; 81-0039.
34	62	96	48	**Sakano H, Rogers J H, Hüppi K, Brack C, Traunecker A, Maki R, Wall R & Tonegawa S.** Domains and the hinge region of an immunoglobulin heavy chain are encoded in separate DNA segments. *Nature* 277:627-33, 1979. Basel Inst. Immunol., Basel, Switzerland; Univ. Calif. Sch. Med., Los Angeles, CA. 80-0594; 81-0039.
3	50	53	38	**Seidman J G, Max E E & Leder P.** A κ-immunoglobulin gene is formed by site specific recombination without further somatic mutation. *Nature* 280:370-5, 1979. NICHHD, NIH, Bethesda, MD. 80-0594; 81-0039.

Pharmacology

16	52	68	60	**Brunner H R, Gavras H, Waeber B, Kershaw G R, Turini G A, Vukovich R A, McKinstry D N & Gavras I.** Oral angiotensin-converting enzyme inhibitor in long-term treatment of hypertensive patients. *Ann. Intern. Med.* 90:19-23, 1979. Univ. Lausanne, Ctr. Hosp., Lausanne, Switzerland; Boston City Hosp., Thorndike Mem. Labs., Boston, MA. 80-0304; 81-0249.
2	48	50	51	**Costa E & Guidotti A.** Molecular mechanisms in the receptor action of benzodiazepines. *Annu. Rev. Pharmacol. Toxicol.* 19:531-45, 1979. NIMH, NIH, Washington, DC.
7	55	62	36	**Hager W D, Fenster P, Mayersohn M, Perrier D, Graves P, Marcus F I & Goldman S.** Digoxin-quinidine interaction. *N. Engl. J. Med.* 300:1238-41, 1979. Vet. Admin. Med. Ctr.; Univ. Arizona, Hlth. Sci. Ctr. & Dept. Pharm. Sci., Tucson, AZ. 80-0629; 81-1544.
8	51	59	36	**Neu H C, Aswapokee N, Aswapokee P & Fu K P.** HR 756, a new cephalosporin active against gram-positive and gram-negative aerobic and anaerobic bacteria. *Antimicrob. Agents Chemother.* 15:273-81, 1979. Columbia Univ., Coll. Phys. Surg., New York, NY. 80-1056; 81-2077.
8	38	46	60	**Schentag J J, Calleri G, Rose J Q, Cerra F B, DeGlopper E & Bernhard H.** Pharmacokinetic and clinical studies in patients with cimetidine-associated mental confusion. *Lancet* 1:177-81, 1979. SUNY, Schs. Pharm., Med. & Surg.; Millard Fillmore Hosp., Buffalo, NY.

79	80	79 & 80 Total Citations	81	
				Endocrinology
12	34	46	36	**Bergeron J J M, Sikstrom R, Hand A R & Posner B I.** Binding and uptake of ^{125}I-insulin into rat liver hepatocytes and endothelium. *J. Cell Biol.* 80:427-43, 1979. McGill Univ., Depts. Anat. & Med., Montreal, Quebec, Canada; NIDR, NIH, Bethesda, MD. 80-0576; 81-0621.
3	54	57	68	**Catt K J, Harwood J D, Aguilera G & Dufau M L.** Hormonal regulation of peptide receptors and target cell responses. *Nature* 280:109-15, 1979. NICHHD, NIH, Bethesda, MD.
4	42	46	26	**Creutzfeldt W.** The incretin concept today. *Diabetologia* 16:75-85, 1979. Univ. Göttingen, Dept. Med., Göttingen, FRG. 80-0180; 81-0942.
16	30	46	39	**Tamborlane W V, Sherwin R S, Genel M & Felig P.** Reduction to normal of plasma glucose in juvenile diabetes by subcutaneous administration of insulin with a portable infusion pump. *N. Engl. J. Med.* 300:573-8, 1979. Yale Univ., Sch. Med., New Haven, CT. 80-0094; 81-1131.
				Bacteriology
17	41	58	36	**Brenner D J, Steigerwalt A G & McDade J E.** Classification of the Legionnaires' disease bacterium: *Legionella pneumophila*, genus-novum, species-nova, of the family Legionellaceae, familia nova. *Ann. Intern. Med.* 90:656-8, 1979. US Pub. Hlth. Serv., Ctrs. Disease Control, Atlanta, GA. 80-0433; 81-0522.
16	31	47	29	**McKinney R M, Thacker L, Harris P P, Lewallen K R, Hebert G A, Edelstein P H & Thomason B M.** Four serogroups of Legionnaires' disease bacteria defined by direct immunofluorescence. *Ann. Intern. Med.* 90:621-4, 1979. US Pub. Hlth. Serv., Ctrs. Disease Control, Atlanta, GA; Vet. Admin., Wadsworth Med. Ctr.; Univ. Calif., Sch. Med., Los Angeles, CA. 80-0433; 81-0522.
10	48	58	69	**Stoeckenius W, Lozier R H & Bogomolni R A.** Bacteriorhodopsin and the purple membrane of halobacteria. *Biochim. Biophys. Acta* 505:215-78, 1979. Univ. Calif., Cardiovascular Res. Inst., San Francisco, CA. 80-2544; 81-2776.
				Pathology
11	42	53	62	**Kannel W B, Castelli W P & Gordon T.** Cholesterol in the prediction of atherosclerotic disease. *Ann. Intern. Med.* 90:85-91, 1979. NHLBI, NIH, Bethesda, MD; Framingham Heart Disease Epidemiol. Study, Framingham, MA; Boston Univ., Med. Ctr., Boston, MA.
5	65	70	95	**Moncada S & Vane J R.** Arachidonic acid metabolites and the interactions between platelets and blood-vessel walls. *N. Engl. J. Med.* 300:1142-7, 1979. Wellcome Res. Labs., Dept. Prostaglandin Res., Kent, UK.
1	48	49	78	**Prockop D J, Kivirikko K I, Tuderman L & Guzman N A.** The biosynthesis of collagen and its disorders. *N. Engl. J. Med.* 301:13-23, 1979. Rutgers Univ., Coll. Med. & Dent. New Jersey, Piscataway, NJ. 80-2608; 81-2868.

79	80	79 & 80 Total Citations	81	
				Myophysiology
4	42	46	49	**Fambrough D M.** Control of acetylcholine receptors in skeletal muscle. *Physiol. Rev.* 59:165-217, 1979. Carnegie Inst. Washington, Dept. Embryol., Baltimore, MD. 81-1512.
8	38	46	21	**Nairn A C & Perry S V.** Calmodulin and myosin light-chain kinase of rabbit fast skeletal muscle. *Biochem. J.* 179:89-97, 1979. Univ. Birmingham, Dept. Biochem., Birmingham, UK. 80-0045; 81-0046.

Figure 2: The 1979 life sciences articles which are among the 100 most-cited in 1979-1981, and which do not appear in Figure 1 mainly because of late publication dates.

79	80	81	Total Citations 1979-81	
2	42	56	100	**Abelson J.** RNA processing and the intervening sequence problem. *Annu. Rev. Biochem.* 48:1035-69, 1979. Univ. Calif., Dept. Chem., La Jolla, CA. 81-0002.
10	32	55	97	**Borgeat P & Samuelsson B.** Transformation of arachidonic acid by rabbit polymorphonuclear leukocytes. *J. Biol. Chem.* 254:2643-6, 1979. Karolinska Inst., Dept. Chem., Stockholm, Sweden. 80-0043; 81-0371.
6	36	46	88	**Bravo E L & Tarazi R C.** Converting enzyme inhibition with an orally active compound in hypertensive man. *Hypertension* 1:39-46, 1979. Cleveland Clinic Fdn., Res. Div., Cleveland, OH. 80-0304; 81-0249.
3	39	48	90	**Cantor H & Gershon R K.** Immunological circuits: cellular composition. *Fed. Proc.* 38:2058-64, 1979. Harvard Univ., Sch. Med.; Sidney Farber Cancer Inst., Boston, MA; Yale Univ., Sch. Med., New Haven, CT.
2	37	75	114	**Carpenter G & Cohen S.** Epidermal growth factor. *Annu. Rev. Biochem.* 48:193-216, 1979. Vanderbilt Univ. Sch. Med., Nashville, TN.
0	41	54	95	**Chow L T, Broker T R & Lewis J B.** Complex splicing patterns of RNAs from the early regions of adenovirus-2. *J. Mol. Biol.* 134:265-303, 1979. Cold Spring Harbor Lab., Cold Spring Harbor, NY. 80-0086; 81-0081.
8	32	48	88	**Frank M M, Hamburger M I, Lawley T J, Kimberly R P & Plotz P H.** Defective reticuloendothelial system Fc-receptor function in systemic lupus erythematosus. *N. Engl. J. Med.* 300:518-23, 1979. NIAID, NIH; NCI, NIH; NIAMDD, NIH, Bethesda, MD. 81-1812.
10	33	50	93	**Frizzell R A, Field M & Schultz S G.** Sodium-coupled chloride transport by epithelial tissues. *Amer. J. Physiol.* 236:F1-8, 1979. Univ. Pittsburgh, Sch. Med., Pittsburgh, PA; Univ. Chicago, Dept. Med., Chicago, IL; Mount Desert Island Biol. Lab., Salsbury Cove, ME.
3	40	42	85	**Krikorian J G, Burke J S, Rosenberg S A & Kaplan H S.** Occurrence of non-Hodgkin's lymphoma after therapy for Hodgkin's disease. *N. Engl. J. Med.* 300:452-8, 1979. Stanford Univ., Sch. Med., Stanford, CA. 80-0960; 81-0292.
5	39	51	95	**Parodi A J & Leloir L F.** The role of lipid intermediates in the glycosylation of proteins in the eucaryotic cell. *Biochim. Biophys. Acta* 559:1-37, 1979. Wellcome Res. Labs., Dept. Microbiol., Research Triangle Park, NC; Inst. Invest. Bioquím. Fund. Campomar, Buenos Aires, Argentina. 80-2009.
2	37	50	89	**Prockop D J, Kivirikko K I, Tuderman L & Guzman N A.** The biosynthesis of collagen and its disorders. *N. Engl. J. Med.* 301:77-85, 1979. Rutgers Univ., Coll. Med. & Dent. New Jersey, Piscataway, NJ. 80-2608; 81-2868.

79	80		Total Citations 979-81	
3	35	62	100	**Rittenhouse-Simmons S.** Production of diglyceride from phosphatidylinositol in activated human platelets. *J. Clin. Invest.* 63:580-7, 1979. Boston Vet. Admin. Med. Ctr.; Boston Univ., Sch. Med., Boston, MA. 80-0520; 81-0558.
8	34	48	90	**Shibata T, DasGupta C, Cunningham R P & Radding C M.** Purified *Escherichia coli recA* protein catalyzes homologous pairing of superhelical DNA and single-stranded fragments. *Proc. Nat. Acad. Sci. US* 76:1638-42, 1979. Yale Univ., Sch. Med., New Haven, CT. 80-1036; 81-0108.
5	39	43	87	**Shoyab M, De Larco J E & Todaro G J.** Biologically active phorbol esters specifically alter affinity of epidermal growth factor membrane receptors. *Nature* 279:387-91, 1979. NCI, NIH, Bethesda, MD. 80-0485; 81-0945.
1	40	63	104	**Thomas E D, Buckner C D, Clift R A, Fefer A, Johnson F L, Neiman P E, Sale G E, Sanders J E, Singer J W, Shulman H, Storb R & Weiden P L.** Marrow transplantation for acute nonlymphoblastic leukemia in first remission. *N. Engl. J. Med.* 301:597-9, 1979. Fred Hutchinson Cancer Res. Ctr.; Univ. Washington, Sch. Med.; Children's Orthoped. Hosp., Seattle, WA. 80-2605; 81-0332.
11	28	54	93	**Volgelstein B & Gillespie D.** Preparative and analytical purification of DNA from agarose. *Proc. Nat. Acad. Sci. US* 76:615-9, 1979. NCI, NIH, Bethesda, MD.
7	33	45	85	**Wang J K, Nauss L A & Thomas J E.** Pain relief by intrathecally applied morphine in man. *Anesthesiology* 50:149-51, 1979. Mayo Clinic, Depts. Anesthes. & Neurol.; Mayo Sch. Med., Rochester, MN. 80-0511; 81-0547.
1	42	76	119	**Watson J, Gillis S, Marbrook J, Mochizuki D & Smith K A.** Biochemical and biological characterization of lymphocyte regulatory molecules. *J. Exp. Med.* 150:849-61, 1979. Univ. Calif. Sch. Med., Irvine, CA; Univ. Auckland, Dept. Cell Biol., Auckland, New Zealand; Dartmouth Hitchcock Med. Ctr. & Norris Cotton Cancer Ctr., Hanover, NH. 80-0001.
1	37	72	110	**Weil P A, Luse D S, Segall J & Roeder R G.** Selective and accurate initiation of transcription at the Ad2 major late promotor in a soluble system dependent on purified RNA polymerase II and DNA. *Cell* 18:469-84, 1979. Washington Univ., Sch. Med., St. Louis, MO. 81-2600.
2	41	39	82	**Wickner W.** The assembly of proteins into biological membranes: the membrane trigger hypothesis. *Annu. Rev. Biochem.* 48:23-45, 1979. Univ. Calif., Mol. Biol. Inst. & Dept. Biol. Chem., Los Angeles, CA.
1	41	56	98	**Wolff D J & Brostrom C O.** Properties and functions of the calcium-dependent regulator protein. *Adv. Cyclic Nuc. Res.* 11:27-88, 1979. Rutgers Univ., Coll. Med. & Dent. New Jersey, Dept. Pharmacol., Piscataway, NJ.
6	33	51	90	**Yamada K M & Kennedy D W.** Fibroblast cellular and plasma fibronectins are similar but not identical. *J. Cell Biol.* 80:492-8, 1979. NCI, NIH, Bethesda, MD. 80-0107; 81-0125.

ISI/BIOMED cluster. Of the 17 papers that did not make a cluster, some may represent concepts that are too new to have been co-cited often with other papers. But some are not included in a cluster simply because they were cited too frequently to meet the requirements of co-citation strength.

Only seven of the papers in Figure 1 are single-author works. Twenty-two papers have two authors, 22 have three, and 19 have four. Ten papers have five authors, seven have six, seven have seven, three have eight, one has nine, three have ten, and one has 11 authors.

Twenty authors have more than one paper on the list. One, P. Leder, has four papers. Four authors—R. B. Herberman, E. L. Reinherz, B. Samuelsson, and S. F. Schlossman—each have three

Table 1: *1980-1981 research fronts which contain* 1979 most-cited life sciences papers as core documents. A = research front number. B = research front name. C = number of 1979 most-cited life sciences papers included in the core of each research front.

A	B	C
80-0001	Helper and suppressor T-cell factors in immune response regulation	2
80-0019	Transformation by and transcription of carcinogenic viruses	4
80-0027	Transformation, transcription, and DNA tumor-virus antigens	3
80-0043	Leukotrienes and slow reacting substances of anaphylaxis	4
80-0045	Calmodulin and protein phosphorylation regulation	2
80-0105	Assembly of mitochondrial membrane-systems	2
80-0107	Structure and biological activity of fibronectin	2
80-0173	Transposons and mobile-dispersed-genetic elements	2
80-0229	Clinical aspects of estrogens in endometrial cancer	2
80-0304	Pharmacokinetics of captopril in renal hypertension	2
80-0341	Expression, regulation, movement, and recombination of transformed cell-lines	2
80-0359	*Gene-related Hb diseases and* thalassemia	6
80-0433	Geographical analysis of Legionnaires-disease	2
80-0485	Tumor-promotor-inhibition of EGF in myeloid leukemia	2
80-0560	Molecular genetics of DNA viruses	2
80-0594	Molecular genetics of Ig complexes	5
80-1036	Initiation of genetic recombination promoted by recA protein of E. coli	2
80-1428	Interferon-mediated control of natural killer-cell activity in tumor cells	2
80-1573	Monoclonal antibodies reactive with human cytotoxic T-cells in lymphocytic malignancies	3
80-2023	Analysis of natural killer-cell activity in immunodeficiency	3
80-2608	Structure of procollagen and collagen types in related diseases	2
81-0018	Sarcoma-virus transforming-proteins	4
81-0039	Organization, rearrangement and Ig gene-expression	5
81-0046	Calmodulin interaction with myosin light-chain-kinase	2
81-0108	E. coli recA protein activities	2
81-0125	Structure and function of fibronectin	2
81-0140	Cytochrome-c-oxidase structure and the mitochondrial genome	2
81-0190	Proviral DNA of retrovirus, chromosome integration and RNA viral-transformation	4
81-0246	Cholecystokinin receptors in brain	2
81-0249	Studies of the angiotensin-converting enzyme-inhibitor captopril	2
81-0252	Estrogens and endometrial cancer and breast cancer	2
81-0371	Leukotrienes and lipoxygenase-pathways	4
81-0428	Defects in the beta-globin gene in beta-thalassemia	2
81-0522	Pathology of Legionella pneumonia	2
81-0817	SV-40 and polyoma-virus T-antigens	2
81-2464	Nucleotide sequences of globin-gene and other genes	2
81-2489	T-cell imbalance in disease	2

Table 2: The 27 journals represented on the list of 102 1979 life sciences papers most cited in 1979-1980. The numbers in parentheses are the impact factors for the journals. (Impact equals average number of citations received by articles published in that journal.) Data were taken from the 1979 *Journal Citation Reports*®. The figures at the right indicate the number of papers from each journal which appears on the list.

Proc. Nat. Acad. Sci. US (8.9)	24
Nature (5.9)	16
Cell (13.6)	14
N. Engl. J. Med. (13.6)	9
Ann. Intern. Med. (5.6)	4
Science (5.7)	4
J. Immunol. (5.8)	3
Annu. Rev. Biochem. (27.7)	2
Brain Res. (3.8)	2
Immunol. Rev. (11.2)	2
J. Biol. Chem. (6.1)	2
J. Cell Biol. (8.4)	2
J. Exp. Med. (9.7)	2
Life Sci. (3.1)	2
Nucl. Acid. Res. (4.4)	2
Annu. Rev. Genet. (7.6)	1
Annu. Rev. Pharmacol. Toxicol. (6.1)	1
Antimicrob. Agents Chemother. (3.1)	1
Biochem. Biophys. Res. Commun. (3.3)	1
Biochem. J. (2.9)	1
Biochim. Biophys. Acta (2.9)	1
Diabetologia (4.6)	1
Eur. J. Immunol. (4.9)	1
J. Virol. (4.5)	1
Lancet (8.5)	1
Physiol. Rev. (19.9)	1
Virology (3.8)	1

papers. Fifteen authors have two papers—G. D. Bonnard, J. Y. Djeu, S. Hammarström, H. T. Holden, K. Hüppi, T. Maniatis, E. E. Max, R. J. Miller, R. C. Murphy, J. R. Ortaldo, H. Sakano, J. G. Seidman, S. H. Snyder, S. Tonegawa, and D. J. Weatherall.

The papers in this study were published in the 27 journals listed in Table 2.

Table 3: The institutional affiliations of the authors on the list, and the number of papers produced by each institution.

Basel Inst. Immunol. Basel, Switzerland		2
Beth Israel Hospital Boston, MA		1
Boston City Hospital, MA		1
Boston Univ., MA		2
California Inst. Technology Pasadena, CA		3
Carnegie Inst. Washington Baltimore, MD		1
Children's Hosp. Med. Ctr., Boston, MA		1
City of Hope Nat. Med. Ctr. Duarte, CA		1
CNRS, France		2
Inst. Chim. Biol., Strasbourg	1	
Inst. Pasteur, Paris	1	
Cold Spring Harbor Lab., NY		1
Columbia Univ. Coll. Physicians & Surgeons, NY		2
Cornell Univ. Med. Coll., NY		1
Fed. Univ. Minas Gerais Belo Horizonte, Brazil		1
Framingham Heart Disease Epidemiol. Study, MA		1
Fox Chase Cancer Ctr., Phila., PA		1
Genentech, Inc., San Francisco, CA		1
Group Health Cooperative of Puget Sound Seattle, WA		1
Hacettepe Univ., Ankara, Turkey		1
Harvard Univ. and Sch. Med. Cambridge, MA		13
Hoffmann-La Roche, Nutley, NJ		1
Howard Hughes Med. Inst., Seattle, WA		1
Imperial Cancer Research Fund London, UK		3
Imperial Coll., London, UK		1
Jichi Med. Sch., Tochigi-ken, Japan		1
Johns Hopkins Univ., Baltimore, MD		3
Justus Liebig Univ., Giessen, FRG		1
Karolinska Inst., Stockholm, Sweden		4
Kyoto Univ., Japan		1
Litton Bionetics, Inc. Kensington, MD		2
Massachussetts General Hospital Boston, MA		1
Massachusetts Inst. Technology Cambridge, MA		4
Max Planck Inst., Tübingen, FRG		3
McGill Univ., Montreal, Canada		1
Michigan State Univ., East Lansing, MI		1
Millard Fillmore Hosp., Buffalo, NY		1
MRC Lab. Mol. Biol., Cambridge, UK		2
National Institutes of Health		16
NCI	5	
NHLBI	1	
NICHHD	5	
NIDR	1	
NIMH	2	
NINCDS	2	
Newcastle Gen. Hosp., Newcastle upon Tyne, UK		1
Oak Ridge Nat. Lab., Oak Ridge, TN		1
Ortho Pharmaceutical Corp. Raritan, NJ		1
Peter Bent Brigham Hospital Boston, MA		1
Princeton Univ., NJ		2
Radcliffe Infirmary Oxford, UK		1
Roche Inst. Mol. Biol., Nutley, NJ		1
Rockefeller Univ., New York, NY		3
Royal Victoria Infirmary, Newcastle upon Tyne, UK		1
Rutgers Univ., Piscataway, NJ		1
Salk Inst. Biol. Studies, La Jolla, CA		2
Sidney Farber Cancer Inst., Boston, MA		6
SUNY, Buffalo, NY		1
Stanford Univ., CA		7
Tokyo Metropolitan Inst. Med. Science, Japan		1
Univ. Aarhus, Denmark		1
Univ. Amsterdam, the Netherlands		2
Univ. Arizona, Tucson, AZ		1
Univ. Basel, Switzerland		1
Univ. Birmingham, UK		1
Univ. British Columbia Vancouver, Canada		1
Univ. California		7
Berkeley	1	
Los Angeles	2	
San Francisco	4	
Univ. Chicago, IL		2
Univ. Göttingen, FRG		1
Univ. Lausanne, Switzerland		1
Univ. Leiden, the Netherlands		1
Univ. London, UK		1
Univ. Oxford, UK		3
Univ. Pennsylvania, Phila., PA		2
Univ. Perugia, Italy		1
Univ. Texas Health Sciences Ctr. Dallas, TX		1
Univ. Tokyo, Japan		1
Univ. Uppsala, Sweden		1
Univ. Washington, Seattle, WA		1
Univ. Wisconsin, Madison, WI		1
Univ. Wyoming, Laramie, WY		1
US Public Health Service Ctrs. Disease Control, Atlanta, GA		2
Vet. Admin. Med. Ctr., Tucson, AZ		1
Vet. Admin., Wadsworth Med. Ctr., Los Angeles, CA		1
Wellcome Res. Labs., Kent, UK		1
Wellcome Res. Labs., Research Triangle Park, NC		1
Yale Univ. and Sch. Med., New Haven, CT		2

The top three journals accounted for more than half of the papers. As in past studies, these journals are *Proceedings of the National Academy of Sciences of*

the USA (24 papers), *Nature* (16), and *Cell* (14). This also illustrates a bias in the study. As in other studies of high impact papers, those in fields like molecular biology will dominate, not only because there are so many of them, but because they contain on the average close to 30 references per paper.

The authors in this study came from 79 institutions in 13 countries. These are listed in Table 3. As in past studies, a majority of the institutions, 48, are in the US. Ten institutions are in the UK, four are in Japan, and three each are in the Federal Republic of Germany and Switzerland. Canada, the Netherlands, and Sweden each have two of the institutions, while Brazil, Denmark, France, Italy, and Turkey each have one. The National Institutes of Health again account for more papers, 16, than any other institution. Harvard University is second, with 13 papers. Without exception, all of the papers in this study were published in English.

The papers in Figure 1 fall into 12 broad subject categories: molecular genetics, neuroendocrinology/neurophysiology, virology, immunology, cancer research, cell biology/biochemistry, immunogenetics, pharmacology, endocrinology, bacteriology, pathology, and myophysiology. The molecular genetics papers are subdivided into nucleic acid structure, general gene expression and regulation, and globin gene expression. The cancer research papers are divided into basic and clinical papers.

Fourteen molecular genetics papers deal with nucleic acid structure, including the most-cited paper in this study. That paper, by S. Nakanishi and colleagues, Kyoto University, Japan, reports the nucleotide sequence of a segment of precursor DNA of two pituitary hormones. The fourth most-cited paper, by G. M. Wahl and colleagues, also appears in this group. It deals with the analysis and purification of DNA fragments. That paper received 116 citations.

Nine molecular genetics papers are concerned with general gene expression. These papers deal largely with the process of transforming cells by the addition of other genes, and the process of DNA repair. Eight additional papers reported on the structure and characteristics of genes for hemoglobin, the oxygen-carrying component of blood.

The 13 neuroendocrinology/neurophysiology papers include the second most-cited paper in this study. That paper, by J. W. Kebabian and D. B. Calne, discusses receptors for dopamine, an important neurotransmitter. Four papers extend the knowledge of endogenous opiates, such as enkephalin, and their receptors. Other papers deal with the transmission of messages through the nervous system, and the identification of certain hormones which affect the nervous system.

Nearly all of the 11 virology papers are concerned with viruses which produce tumors in animals. These include the polyoma virus and simian virus 40 (SV 40). Three papers in this group deal with the latter. Papers on SV 40 were also well represented in our study of the highly cited papers of 1978.[2]

There are ten immunology papers in this study. As in previous years, considerable interest is focused on T cells. Four papers in this group deal with T cells, which can recognize harmful antigens and regulate the production of appropriate antibodies. Two papers in this group deal with interferon.

Two of the four clinical cancer research papers are concerned with estrogen-induced cancer of the endometrium, or uterine lining. The others discuss the use of the drug bromocriptine to reduce pituitary tumors, and the risk of skin cancer as a side effect of a treatment for

psoriasis. The three basic cancer research papers examine the process by which agents promote or induce tumors.

There are seven cell biology/biochemistry papers in this study. The one by J. L. Goldstein and colleagues is the third most-cited paper on the list, with 126 citations. This review article discusses receptor-mediated endocytosis, the process by which proteins and peptides enter cells. Other papers in this group deal with various aspects of cell chemistry.

Immunogenetics accounts for six papers. Five of them deal with the genetic determinants of immunoglobin, a protein with antibody properties. The paper by J. Klein discusses the major histocompatibility complex (MHC), a series of genes that defines each individual's immune "identity." The MHC also defines the compatibility of recipients for organ transplants.

The five pharmacology papers each deal with a different specific drug. The paper by J. J. Schentag and colleagues concerns cimetidine, an important new drug for treating peptic ulcers, a topic which I have discussed in a previous essay.[6] The paper discusses "mental confusion" as a possible side effect when the drug is administered to patients with liver or kidney dysfunction.

Three of the four papers in the endocrinology group deal with insulin, the hormone that regulates the body's use of sugars for fuel. The paper by K. J. Catt and colleagues is a review of the hormonal regulation of peptide receptors.

Two of the three bacteriology papers discuss the identification and classification of the Legionnaires' disease bacterium. Papers on Legionnaires' disease also appeared in past studies in this series.

Of the three pathology papers, one is a review of the relationship between serum cholesterol and atherosclerosis; one deals with collagen, the major molecule of connective tissue; and one discusses arachidonic acid metabolites, substances which contract and dilate blood vessels and muscles.

The list is completed by two papers in myophysiology, the study of muscle function. The paper by D. M. Fambrough is a review of receptors for acetylcholine, a neurotransmitter, in skeletal muscle. The paper by A. C. Nairn and S. V. Perry describes the relationship between myosin light-chain kinase and the protein calmodulin. Myosin light-chain kinase "activates" myosin, the most abundant protein in muscle, which is a component responsible for muscle contraction and relaxation.

Most of the papers in Figure 1 will continue to be highly cited in years to come. While there have been no definitive studies, citation frequency shortly after publication is one of the best indicators of future citation frequency. It is important to note that some high impact 1979 papers did not make the list simply because of publication artifacts. Some papers are excluded because they were published late in the year, while others bear "false" publication dates.[7] In Figure 2, we've listed the 1979 papers that would have been included if we had taken 1981 citations into account. Some of these, however, may be examples of "delayed recognition"[8] for a variety of reasons.

In closing, let me remind you that the dominance of molecular biology in these lists is in part due to the size of the biochemical literature as well as the high number of references per paper. These lists could easily be extended both comprehensively and selectively. If any journal editor is interested in learning more about the most-cited papers in his or her journal, please do not hesitate to contact *ISI Search Service*.[9] Furthermore, in the

near future, you will be able to call up lists of core papers in the ISI search system for any of the 3,000 biomedical research fronts we identify each year. Of course, there are similar core literatures for mathematics, earth sciences, etc.

The next essay in this series will examine the 1979 physical sciences papers that were highly cited shortly after publication.

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