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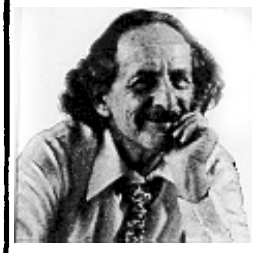

Current Comments®

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The Articles Most Cited in the *SCI* from 1961 to 1982. 6. More *Citation Classics* to Think About

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Last year in a multipart series published in *Current Contents*® (*CC*®),[1] we discussed the 500 papers most cited in the *Science Citation Index*® (*SCI*®) from 1961 to 1982. Each part of the series covered exactly 100 articles. The fifth portion summarized the data from these studies. Overall, methods papers in the life sciences predominated. To continue the series, we have collected data on the sixth group of 100 papers shown in Table 1. They are in alphabetic order by first author. These papers all received at least 861 citations, and the most cited received 935.

Each article's 1983 citation count is in parentheses in Table 1. These additional data were not used to determine which papers would be included in this study. But they provide us with some additional current information about the use of these classics. For example, the paper by Fay Ajzenberg-Selove and Tom Lauritsen on energy levels of light nuclei received 923 citations from 1961 to 1982, but was not cited at all in the 1983 literature. And the paper by P.M. Endt and C. van der Leun, University of Utrecht, the Netherlands, which also discussed energy levels of nuclei, with special emphasis on nuclear spectroscopy, was cited 865 times from 1961 to 1982 but only once in 1983. Both papers are review articles. The latter paper is the fourth version of their review. It received the bulk of its citations over a period of only six years. Then it was superseded by their next review published in 1973.[2,3]

The paper by Ajzenberg-Selove and Lauritsen is the sixth version in a review series that was started by Lauritsen in 1948. Ajzenberg-Selove, now at the University of Pennsylvania, Philadelphia, commented on it in a 1979 *Citation Classic*™ commentary. "In 1952, the first in our joint set of papers was some 80 pages long. The 1959 article cited here was 340 pages. The subsequent papers, having to cope with an information explosion, could no longer deal with all the nuclei from ^{5}He to ^{24}Ne in a single manuscript. Instead evaluations are now prepared on 2-6 mass chains at a time...and each of these evaluations is usually a complete issue of *Nuclear Physics*. Every year some 1,500 scientific papers deal with the properties of the nuclei with A = 5-20 [angstroms]. Yet our knowledge of these nuclei is still incomplete and more information is needed to understand these nuclei better...."[4]

Asterisks in Table 1 indicate the papers that have been subjects of *Citation Classic* commentaries—33 to date. We invite the authors of those articles not yet discussed in *CC* to comment on their papers. We will also send these authors formal invitations in the near future, but sometimes they are difficult to track down.

The 500 *SCI* papers discussed so far in this series have included many methods

papers. This group of 100 is no exception. We identified at least 38 articles that describe new methods or modifications of older techniques. But almost twice that number appeared in the first part of the series. About 50 appeared in the fifth group of 100 papers. So, the percentage of methods papers in this series is slowly declining. We'll summarize these findings in more detail once we have listed at least 1,000 papers. Review papers are also well represented in this group of papers—about 13 percent. Two items are "letters." Keep in mind that not all the papers can be clearly defined as methodological, theoretical, review, and so on. This problem was discussed earlier.[5]

Papers can also be roughly classified as life or physical sciences articles. One way that we do this is to look at the journals in which they were published. Twenty-five articles in Table 1 were published in 15 physical sciences journals—five alone in the *Journal of the American Chemical Society*, and three each in the *Journal of Chemical Physics* and *Physical Review*. Life sciences journals published 66 of the papers. Of these, 11 were published in the *Journal of Biological Chemistry*. However, none of these is younger than 15 years, and most are from the 1950s. Multidisciplinary journals, such as *Science* and *Nature*, account for an additional six papers, five in the life sciences and one in the physical sciences. Table 2 gives the names of the journals that published at least two of the papers listed. The table also provides the 1983 impact factors for each journal. It does not include such titles as *Arkiv för Kemi* or *Bell System Technical Journal*, the latter accounting for the famous Claude E. Shannon paper on the mathematical theory of communication.

A chronologic analysis is provided in Table 3. One-fourth of the articles in Table 1 were published from 1965 to 1969. Sixty-three percent were published in the 1960s and 1970s, while 33 percent were published in the 1940s and 1950s. These percentages have remained constant throughout the series. The oldest paper was published in *Annalen der Physik* in 1908 by Gustav Mie. It is one of three articles in Table 1 written in German. This paper discusses the electric and magnetic vibrations and optical properties of particles in colloidal solutions.[6] Interestingly, it continues to be heavily cited even today—45 times in 1983 alone, 75 years later. It is interesting to speculate why it has not become the common wisdom of physics, which often leads to obliteration of citations to classic work.

The most recent paper was authored by Tavia Gordon, William P. Castelli, Marthana C. Hjortland, William B. Kannel, and Thomas R. Dawber, National Heart, Lung, and Blood Institute, National Institutes of Health (NIH), Bethesda, Maryland. Published in 1977 in the *American Journal of Medicine*, the paper discusses the inverse relation between high-density lipoprotein (HDL) fraction blood levels, and the incidence of coronary heart disease. HDLs are involved in the transport of cholesterol through the blood and may serve a protective function against coronary heart disease. The authors identified HDL as the major potent lipid risk factor in heart disease.[7] The different fractions of lipoproteins—very low density, intermediary density, low density, and high density—and their role in developing and protecting against atherosclerotic disease have been explored in a number of papers by the NIH group. One of their articles[8] was discussed in a recent essay about the *Annals of Internal Medicine*.[9]

Not surprisingly, many authors in this series have been recognized by the Nobel Prize. In Table 1 we identified eight winners, or four percent of the 202

Table 1: The sixth 100 most-cited articles, 1961-1982 *SCI*®, arranged in alphabetic order by first author. A = 1961-1982 citations, 1983 citations appear in parentheses. B = bibliographic data. An asterisk (*) indicates that the paper was the subject of a *Citation Classic*™ commentary. The issue and year of the commentary follow the bibliographic reference.

A	B
923 (0)	*Ajzenberg-Selove F & Lauritsen T. Energy levels of light nuclei. VI. *Nucl. Phys.* 11:1-340, 1959. (13/79/PC&ES)
880 (109)	Ames B N. Assay of inorganic phosphate, total phosphate and phosphatases. *Meth. Enzymology* 8:115-8, 1966.
905 (39)	Anden N-E, Butcher S G, Corrodi H, Fuxe K & Ungerstedt U. Receptor activity and turnover of dopamine and noradrenaline after neuroleptics. *Eur. J. Pharmacol.* 11:303-14, 1970.
881 (0)	Anden N-E, Dahlstrom A, Fuxe K, Larsson K, Olson L & Ungerstedt U. Ascending monoamine neurons to the telencephalon and diencephalon. *Acta Physiol. Scand.* 67:313-26, 1966.
914 (97)	Anderson P W. Absence of diffusion in certain random lattices. *Phys. Rev.* 109:1492-3, 1958.
920 (75)	Atkinson D E. The energy charge of the adenylate pool as a regulatory parameter. Interaction with feedback modifiers. *Biochemistry—USA* 7:4030-4, 1968.
868 (73)	Avrameas S. Coupling of enzymes to proteins with glutaraldehyde. *Immunochemistry* 6:43-52, 1969.
932 (62)	Bethe H. Zur Theorie des Durchgangs schneller Korpuskularstrahlen durch Materie (The theory of transition of fast corpuscular rays through matter). *Ann. Phys.—Leipzig* 5:325-400, 1930.
895 (57)	Blobel G & Potter V R. Nuclei from rat liver: isolation method that combines purity with high yield. *Science* 154:1662-5, 1966.
907 (33)	Blomback B & Blomback M. Purification of human and bovine fibrinogen. *Ark. Kem.* 10:415-43, 1956.
885 (72)	Born G V R & Cross M J. The aggregation of blood platelets. *J. Physiol.—London* 168:179-96, 1963.
875 (47)	Brightman M W & Reese T S. Junctions between intimately apposed cell membranes in the vertebrate brain. *J. Cell Biol.* 40:648-77, 1969.
919 (26)	Britten R J & Davidson E H. Gene regulation for higher cells: a theory. *Science* 165:349-57, 1969.
866 (38)	Brown H C & Okamoto Y. Electrophilic substituent constants. *J. Amer. Chem. Soc.* 80:4979-87, 1958.
904 (49)	Brunner K T, Mauel J, Cerottini J-C & Chapuis B. Quantitative assay of the lytic action of immune lymphoid cells on ^{51}Cr-labelled allogeneic target cells *in vitro*; inhibition by isoantibody and by drugs. *Immunology* 14:181-96, 1968.
909 (19)	Burgess R R. A new method for the large scale purification of *Escherichia coli* deoxyribonucleic acid-dependent ribonucleic acid polymerase. *J. Biol. Chem.* 244:6160-7, 1969.
932 (79)	Cantor H & Boyse E A. Functional subclasses of T lymphocytes bearing different Ly antigens. I. The generation of functionally distinct T-cell subclasses is a differentiative process independent of antigen. *J. Exp. Med.* 141:1376-89, 1975.
926 (115)	*Carbone P P, Kaplan H S, Musshoff K, Smithers D W & Tubiana M. Report of the committee on Hodgkin's disease staging classification. *Cancer Res.* 31:1860-1, 1971. (50/83/CP)
893 (53)	Carlsson A & Lindqvist M. Effect of chlorpromazine or haloperidol on formation of 3-methoxytyramine and normetanephrine in mouse brain. *Acta Pharmacol. Toxicol.* 20:140-4, 1963.
884 (21)	*Caro L G, van Tubergen R P & Kolb J A. High-resolution autoradiography. I. Methods. *J. Cell Biol.* 15:173-88, 1962. (10/78)
921 (87)	*Corfield P W R, Doedens R J & Ibers J A. Studies of metal-nitrogen multiple bonds. I. The crystal and molecular structure of nitridodichlorotris(diethylphenylphosphine) rhenium(V), $ReNCl_2[P(C_2H_5)_2C_6H_5]_3$. *Inorg. Chem.* 6:197-204, 1967. (14/81/PC&ES)
864 (68)	*Dahlqvist A. Method for assay of intestinal disaccharidases. *Anal. Biochem.* 7:18-25, 1964. (16/79/LS)
901 (65)	DuBois A B, Botelho S Y, Bedell G N, Marshall R & Comroe J H. A rapid plethysmographic method for measuring thoracic gas volume: a comparison with a nitrogen washout method for measuring functional residual capacity in normal subjects. *J. Clin. Invest.* 35:322-6, 1956.
902 (56)	*DuBois A B, Botelho S Y & Comroe J H. A new method for measuring airway resistance in man using a body plethysmograph: values in normal subjects and in patients with respiratory disease. *J. Clin. Invest.* 35:327-35, 1956. (6/81/CP)

A	B
866 (15)	*Dunker A K & Rueckert R R. Observations on molecular weight determinations on polyacrylamide gel. *J. Biol. Chem.* 244:5074-80, 1969. (10/81/LS)
889 (8)	Eagle H. Nutrition needs of mammalian cells in tissue culture. *Science* 122:501-4, 1955.
917 (42)	*Ebashi S & Endo M. Calcium ion and muscle contraction. *Progr. Biophys. Mol. Biol.* 18:123-83, 1968. (9/82/LS)
865 (1)	*Endt P M & van der Leun C. Energy levels of Z=11-21 nuclei (IV). *Nucl. Phys. A* 105:1-488, 1967. (5/81/PC&ES)
874 (104)	*Flower R J. Drugs which inhibit prostaglandin biosynthesis. *Pharmacol. Rev.* 26:33-67, 1974. (36/83/LS)
934 (143)	*Geary W J. The use of conductivity measurements in organic solvents for the characterisation of coordination compounds. *Coord. Chem. Rev.* 7:81-122, 1971. (13/81/PC&ES)
880 (172)	Georgi H & Glashow S L. Unity of all elementary-particle forces. *Phys. Rev. Lett.* 32:438-41, 1974.
875 (23)	Gianetto R & de Duve C. Tissue fractionation studies. 4. Comparative study of the binding of acid phosphatase, β-glucuronidase and cathepsin by rat-liver particles. *Biochem. J.* 59:433-8, 1955.
885 (41)	Glock G E & McLean P. Further studies on the properties and assay of glucose 6-phosphate dehydrogenase and 6-phosphogluconate dehydrogenase of rat liver. *Biochem. J.* 55:400-8, 1953.
887 (26)	Good C A, Kramer H & Somogyi M. The determination of glycogen. *J. Biol. Chem.* 100:485-91, 1933.
866 (152)	Gordon T, Castelli W P, Hjortland M C, Kannel W B & Dawber T R. High density lipoprotein as a protective factor against coronary heart disease. *Amer. J. Med.* 62:707-14, 1977.
924 (306)	Grunstein M & Hogness D S. Colony hybridization: a method for the isolation of cloned DNAs that contain a specific gene. *Proc. Nat. Acad. Sci. US* 72:3961-5, 1975.
910 (21)	Gutowsky H S & Holm C H. Rate processes and nuclear magnetic resonance spectra. II. Hindered internal rotation of amides. *J. Chem. Phys.* 25:1228-34, 1956.
911 (28)	*Hamada T & Johnston I D. A potential model representation of two-nucleon data below 315 MeV. *Nucl. Phys.* 34:382-403, 1962. (18/79/PC&ES)
896 (30)	*Hanks J H & Wallace R E. Relation of oxygen and temperature in the preservation of tissues by refrigeration. *Proc. Soc. Exp. Biol. Med.* 71:196-200, 1949. (5/84/LS)
874 (53)	Hodgkin A L & Horowicz P. The influence of potassium and chloride ions on the membrane potential of single muscle fibres. *J. Physiol.—London* 148:127-60, 1959.
935 (52)	Hogeboom G H. Fractionation of cell components of animal tissues. *Meth. Enzymology* 1:16-9, 1955.
929 (20)	Hohorst H J, Kreutz F H & Bucher T. Uber Metabolitgehalte und Metabolit-Konzentrationen in der Leber der Ratte (The metabolite content and concentration in the rat liver). *Biochem. Z.* 332:18-46, 1959.
928 (29)	Hornykiewicz O. Dopamine (3-hydroxytyramine) and brain function. *Pharmacol. Rev.* 18:925-64, 1966.
902 (57)	Hubbell W L & McConnell H M. Molecular motion in spin-labeled phospholipids and membranes. *J. Amer. Chem. Soc.* 93:314-26, 1971.
901 (30)	Hubel D H & Wiesel T N. Receptive fields and functional architecture in two nonstriate visual areas (18 and 19) of the cat. *J. Neurophysiol.* 28:229-89, 1965.
861 (51)	Hubel D H & Wiesel T N. Receptive fields and functional architecture of monkey striate cortex. *J. Physiol.—London* 195:215-43, 1968.
870 (8)	*Hurlbert R B, Schmitz H, Brumm A F & Potter V R. Nucleotide metabolism. II. Chromatographic separation of acid-soluble nucleotides. *J. Biol. Chem.* 209:23-39, 1954 (51/83/LS)
907 (42)	Kaltschmidt E & Wittmann H G. Ribosomal proteins. VII. Two-dimensional polyacrylamide gel electrophoresis for fingerprinting of ribosomal proteins. *Anal. Biochem.* 36:401-12, 1970.
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924 (64) **Shannon C E.** A mathematical theory of communication. *Bell Syst. Tech. J.* 27:379-423, 1948.

866 (20) **Sheehan J C & Hess G P.** Letter to editor. (A new method of forming peptide bonds.) *J. Amer. Chem. Soc.* 77:1067-8, 1955.

875 (104) **Shelanski M L, Gaskin F & Cantor C R.** Microtubule assembly in the absence of added nucleotides. *Proc. Nat. Acad. Sci. US* 70:765-8, 1973.

877 (20) **Silber R H & Porter C C.** The determination of 17,21-dihydroxy-20-ketosteroids in urine and plasma. *J. Biol. Chem.* 210:923-32, 1954.

883 (18) **Singer K, Chernoff A I & Singer L.** Studies on abnormal hemoglobins. I. Their demonstration in sickle cell anemia and other hematologic disorders by means of alkali denaturation. *Blood* 6:413-28, 1951.

869 (39) **Singer S J.** The molecular organization of membranes. *Annu. Rev. Biochem.* 43:805-33, 1974.

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876 (21) **Stork G, Brizzolara A, Landesman H, Szmuszkovicz J & Terrell R.** The enamine alkylation and acylation of carbonyl compounds. *J. Amer. Chem. Soc.* 85:207-22, 1963.

919 (29) **Swift T J & Connick R E.** NMR-relaxation mechanisms of O^{17} in aqueous solutions of paramagnetic cations and the lifetime of water molecules in the first coordination sphere. *J. Chem. Phys.* 37:307-20, 1962.

880 (70) **Terasaki P I & McClelland J D.** Microdroplet assay of human serum cytotoxins. *Nature* 204:998-1000, 1964.

878 (53) **Todaro G J & Green H.** Quantitative studies of the growth of mouse embryo cells in culture and their development into established lines. *J. Cell Biol.* 17:299-313, 1963.

895 (27) ***Van Hove L.** Correlations in space and time and born approximation scattering in systems of interacting particles. *Phys. Rev.* 95:249-62, 1954. (21/77)

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866 (31) ***Wetmur J G & Davidson N.** Kinetics of renaturation of DNA. *J. Mol. Biol.* 31:349-70, 1968. (3/83/LS)

932 (55) **Williams M L, Landel R F & Ferry J D.** The temperature dependence of relaxation mechanisms in amorphous polymers and other glass-forming liquids. *J. Amer. Chem. Soc.* 77:3701-7, 1955.

903 (23) **Wilson T H & Wiseman G.** The use of sacs of everted small intestine for the study of the transference of substances from the mucosal to the serosal surface. *J. Physiol.—London* 123:116-25, 1954.

888 (7) ***Wyatt G R.** The purine and pyrimidine composition of deoxypentose nucleic acids. *Biochem. J.* 48:584-90, 1951. (42/81/LS)

867 (41) ***Zimm B H.** Dynamics of polymer molecules in dilute solution: viscoelasticity, flow birefringence and dielectric loss. *J. Chem. Phys.* 24:269-78, 1956. (27/79/PC&ES)

authors in the study. Three won the Prize for chemistry (H.C. Brown, P. Mitchell, and L. Onsager); three for medicine (C. de Duve, D.H. Hubel, and T.N. Wiesel); and two for physics (H. Bethe and S.L. Glashow). Mitchell of the UK was identified in our recent essay on the most-cited 1981 chemistry articles.[10] Hubel of the US and Wiesel of Sweden shared the 1981 Prize in medicine with Roger Sperry (US) for their work investigating brain organization and function. The Hubel-Wiesel papers listed here discuss brain function in the monkey and the cat. This is the second time in this series that papers by Hubel and Wiesel have appeared.

In fact, while the list of papers represents a tiny fraction of all scientific publications, many of the authors identified in this series have written several of the papers listed so far. For example, Harry Eagle wrote two papers in the late 1950s that discuss nutrition needs and metabolism in mammalian cell cultures. These are now *Citation Classics.* One paper[11] appeared in the first part of this series. The other paper is listed here. While this latter paper is not highly cited today, it has had quite an impact on subsequent research. Figure 1 illustrates this fact. We've also included the citation history for Shannon's paper mentioned earlier. The continued explicit citation of this

Table 2: Journals that published at least two papers in the sixth group of 100 papers most cited from 1961 to 1982, *SCI*®. A = journal title. B = number of papers. C = 1983 impact factor.

A	B	C
J. Biol. Chem.	11	5.8
J. Amer. Chem. Soc.	5	4.5
Anal. Biochem.	4	2.9
J. Physiol.—London	4	3.4
Proc. Nat. Acad. Sci. US	4	8.7
Science	4	7.4
Biochem. J.	3	3.3
J. Cell Biol.	3	9.2
J. Chem. Phys.	3	3.0
Phys. Rev.	3	—
Ann. Phys.—Leipzig	2	0.4
J. Clin. Invest.	2	7.0
J. Exp. Med.	2	11.1
J. Histochem. Cytochem.	2	3.9
J. Mol. Biol.	2	6.7
Meth. Enzymology	2	1.3
Nature	2	9.3
Nucl. Phys.	2	—
Pharmacol. Rev.	2	8.2

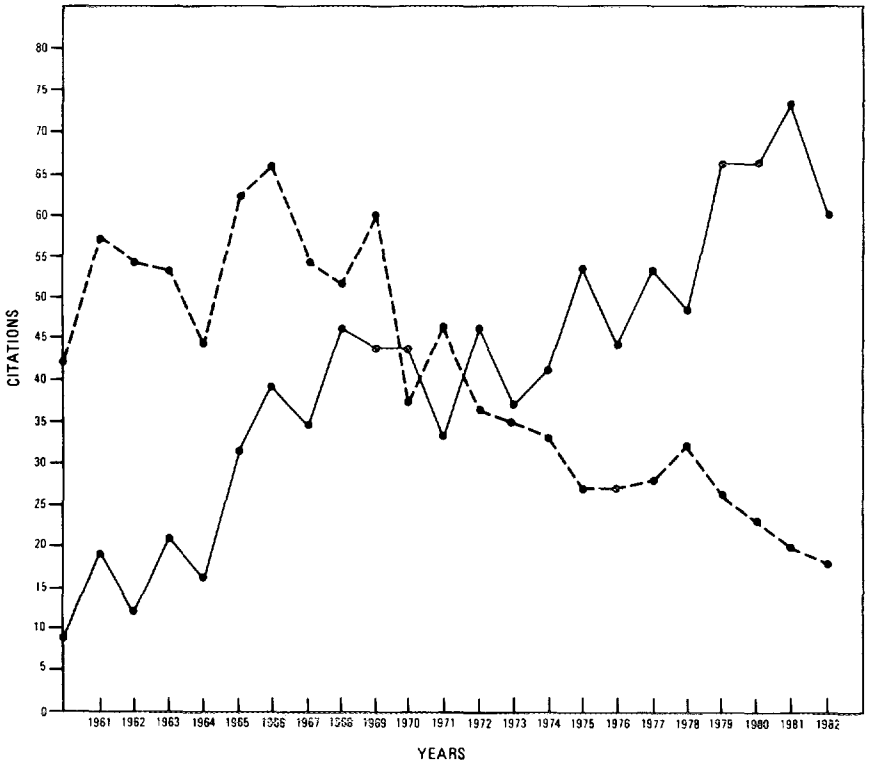
Table 3: Chronologic distribution of publication dates for the sixth group of 100 most-cited papers, 1961-1982, *SCI*®. A = publication year. B = number of papers.

A	B
1900-1910	1
1930-1939	3
1940-1949	5
1950-1954	8
1955-1959	20
1960-1964	18
1965-1969	25
1970-1974	17
1975-1977	3
	100

paper may be due to the continued explosion of literature in that field.

Christian de Duve has also coauthored three papers so far in this series. One of these,[12] which appeared in Part 3, discusses the function of lysosomes, which

Figure 1: Chronologic distribution of citations to Shannon's 1948 paper (solid line) and Eagle's 1955 paper (dotted line).



are minute bodies found in many types of cells and contain enzymes involved in intracellular digestion. His *Citation Classic* commentary on this paper appeared in *CC* recently.[13] His other two papers in this series, one mentioned in Part 1[14] and the other coauthored with R. Gianetto (see Table 1), are part of an 18-part study on tissue fractionation in rat-liver tissue. This multipart study was published between 1951 and 1964. It is important to stress this point because the public has the misguided notion that everything spectacular in science can be identified with one brilliant observation. Science is hard work, conducted over a long period of time. Milestone papers are merely the tip of the iceberg. The analogy is appropriate. Citation analysis gives but one perspective on the size and shape of the mountains (or icebergs) each scientist or group creates in its lifetime.

This concludes our discussion of the sixth group of 100 classics. We'll publish additional lists in the near future.

* * * * *

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