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Classic Papers from the *Proceedings of the National Academy of Sciences*. Part 1. Each Year's Most-Cited Paper, 1955-1984—And Then Some

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The *Proceedings of the National Academy of Sciences of the United States of America* (*PNAS*) began publishing in 1915 as an organ of the National Academy of Sciences (NAS). The NAS is an honorific society that awards membership to a small number of US and foreign scientists distinguished for their outstanding contributions to scientific research. Members are frequently asked to advise the federal government in various scientific and technological matters through academy committees.[1] (p. 79)

One of the privileges of academy membership is the opportunity to contribute unrefereed research papers to *PNAS*, the academy's multidisciplinary journal. Nonmembers also publish papers in *PNAS*, but their work is subject to the normal scholarly routine of refereeing. Since it began, the journal has been dedicated to publishing reports that are of "exceptional importance and broad interest to diverse groups of scientists."[2] In our study of the 1,000 articles most cited between 1961 and 1982,[3] *PNAS* ranked second with *Biochemical Journal* and *Physical Review Letters* for the number of articles included in the study. Only the *Journal of Biological Chemistry* published a larger number of highly cited articles.

Lists of classic papers can be identified in different ways. A year-by-year analysis produces a different group of papers from a list that is compiled strictly on the basis of citation frequency regardless of publication year. Some papers that turn up as most cited in a given year are not cited enough to satisfy the minimum absolute-citation threshold of a multiyear citation study. As a result, in a year-by-year study some of the papers that turn up are those that had an immediate impact for a given year. In this two-part study we identified the most-cited *PNAS* articles in the *Science Citation Index*® (*SCI*®) by using these two different sets of criteria and created two Bibliographies of 50 papers each.

Part 1 covers the year-by-year list of most-cited articles published from 1955 to 1984. To provide selections that reflect the number of citations one can reasonably expect for each year, we selected the two most-cited articles from each of the years between 1960 through 1979 and one from each year between 1955 through 1959 and 1980 through 1984. The 50 articles that constitute this "chronological," or annual, list are arranged alphabetically by first author in Bibliography 1.

In Part 2 of this essay, Bibliography 2 will list the 50 most-cited articles regardless of year, excluding those papers listed in Part 1. This might be referred to as the "absolute," or most-cited overall, list. As in all such lists, I attribute little significance to their ranking. They simply make it easier to provide an interesting, "objective" selection over a long period of time. Naturally, not all of these papers will satisfy your personal criteria for the best *PNAS* papers.

NAS History and Membership

The NAS was established in 1863 as a private institution under a congressional charter. Fifty US scientists were named in the original membership. The charter requires the academy to "investigate, examine, experiment, and report upon any subject of science or art"[1] (p. 596) requested by any department of government. In 1948 the late Raymund L. Zwemer, executive secretary of the academy from 1947 to 1950, observed that three well-known scientists were the first scientific advisers to the government and were instrumental in founding the NAS: Joseph Henry, the first secretary of the Smithsonian Institution; Alexander Dallas Bache, physicist, first president of the academy, and grandson of Benjamin Franklin; and Charles Henry Davis, chief of the Bureau of Navigation, Navy Department.[4]

Many of the early governmental requests for advice from the NAS were practical in nature. The founders' expertise in navigation and the physical sciences was especially useful to the government during the Civil War. In his book on the history of the first 50 years of the academy, Frederick W. True, assistant secretary, Smithsonian Institution, mentions that one of the first requests of the NAS was to find an effective metallic coating to prevent rust from forming on the bottom of iron ships. Another request was for improving the compass readings in these ships. Although many requests were connected with the war effort, the founders also organized committees for more enduring purposes: to determine a standard of metric weights and to prevent the counterfeiting of US paper currency.[5]

The charter also gave the academy the authority to establish its own organization. As a result, although some NAS members were employed by the government, members developed the NAS constitution, its organization, and the rules and regulations of membership independently. Early academy members devised a structure to classify members according to their area of expertise. Today members are categorized into one of the following broad "classes" of science: physical and mathematical sciences; biological sciences; engineering and applied mathematical and physical sciences; medical sciences; behavioral and social sciences; and the newest class, the applied biological and agricultural sciences.[6] Within these classes, members assign themselves to any of the various scientific specialties called "sections."[7] (p. 13) The academy currently identifies 25 scientific specialties as sections.[8]

The academy selects its new members through a complex, formal process. Academy members first submit written proposals for potential candidates to the Nominating Committee of their section. Membership proposals consist of a summary of the nominee's overall and primary scientific accomplishments and a short bibliography. Only US citizens are eligible for academy membership, but up to 15 distinguished foreign scientists can be elected as foreign associates each year. Foreign associates have the same privileges as members except they do not vote for new academy members or officers.[7] (p. 26)

Membership selection begins with votes by each sectional division, progresses to the class divisions, and culminates in a preliminary mail ballot and final ballot by the entire membership at the annual academy meeting.[7] (p. 31-5)

Current Membership

As of the 1987 NAS annual meeting, officials place NAS membership at 1,510 active members, 249 foreign associates, and 82 emeritus members.[8] Although the total number of academy members is not fixed, the NAS constitution restricts the number of new members elected annually. Since 1977, no more than 60 new members have been elected each year, but if a nominee dies before the final election, a majority vote at the annual meeting may elect members posthumously, regardless of quota. In 1987 two members were elected posthumously: George Khoury, molecular virologist, National Cancer Institute, Bethesda, Maryland, and Edward Herbert, professor of chemistry, University of Oregon, Eugene.[9]

Based on a 1985 NAS membership list, the latest data that are available to the public, the majority of members (528) associate themselves in the physical and mathematical sciences. Biological sciences follows with 397 members, and engineering and applied sciences comes next with 212 members. The two smallest classes, the behavioral and social sciences and the medical sciences, have 173 and 132 members, respectively.[10] There are no membership data available for the applied biological and agricultural sciences class, as it is just being organized.[6]

The NAS is not the only organization under the NAS congressional charter. Three other organizations, the National Research Council (NRC), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM), have been added since 1863.[11] Like the NAS, the NAE and the IOM are honorific membership organizations established under the NAS charter in 1964 and 1970, respectively. These independent organizations recognize outstanding achievements in the engineering and medical sciences. The NAE has 1,200 members and the IOM, 600.[11]

Unlike the academies, the NRC is not an honorific society. It functions as the operating agency of the NAS, NAE, and IOM, with 7,900 *volunteer* scientists, engineers, and other professionals serving on its advisory committee.[11] The NRC was established by the NAS in 1916 to coordinate government advisory activities in preparation for US involvement in World War I.[4]

PNAS History

Although the academy issued scientific reports sporadically in its early years, it was not until *PNAS* began publication in 1915 that the institution committed itself to regular scientific publication.[6] In commemorating the NAS centennial in 1963, Rexmond C. Cochrane, historian, noted that during the first 31 years of the NAS, a total of three cumulative volumes of organizational transactions, called *Proceedings*, were published. They appeared in 1877, 1884, and 1895. These issues contained mostly minutes of the NAS meetings and annual reports.[1] (p. 105) But as research in the US rapidly grew after the turn of the century, NAS members realized the need for a multidisciplinary national journal that summarized important research results in a timely manner.

In a letter to *Science* in 1915, George Ellery Hale, NAS foreign secretary from 1910 to 1921 and one of America's finest astronomers, wrote that "the vigorous developments of science in recent years have carried us past the time when all of the special journals could assure early publication; and their very multiplicity has stood in the way of wide foreign circulation."[12] It was believed that *PNAS*, because it represented the published work of an elected membership throughout the US and abroad, was the best qualified to promote the results of American research in all scientific disciplines. Therefore, rather than competing with specialty journals, *PNAS* was designed to supplement them. Edwin Bidwell Wilson, distinguished mathematician and first *PNAS* managing editor, wrote in the first issue of the journal that its aim was to provide a "comprehensive survey of the more important results of the scientific research of this country."[13]

Not for Members Only

PNAS editorial policy is to accept original research articles solely on their merits, from NAS members and nonmembers alike. Members of the NAS, because they are recognized for their significant contributions to research, are able to bypass the refereeing process. In his book that chronicled the 50-year history of *PNAS*, Wilson described the usual editorial policy: "Members assume total responsibility for the propriety and scientific excellence of any manuscript"[14] (p. 10) submitted for publication. Consequently, members' papers are normally published without further evaluation.

In contrast, papers from nonmembers must be sponsored by an active NAS member and approved by at least two referees selected by the sponsoring member. In addition, the title page and abstract of all papers are reviewed before publication by *PNAS* editorial board chairman, Maxine F. Singer, and managing editor, Frances Zwanzig. "If the antennae go up on any of the papers, further reviews will be requested," said Zwanzig, "but we certainly don't do it often."[15]

The typical turnaround time for most papers, regardless of the author's membership status, is 14 weeks. According to Zwanzig, papers from nonmembers constitute over 75 percent of the papers published in 1986.[15] Statistics from early *PNAS* editorial reports show that over half the articles in the 1915-1919 *PNAS* volumes were contributed by nonmembers.[14] (p. 9-10) Zwanzig views this uneven proportion as a reflection of the prestigious nature of academy membership. "There are so many more scientists who are not members of the academy and want to publish in the journal," she said.[15]

A High-Ranking Journal

Since 1915 *PNAS* has published over 34,000 research papers, symposia, and academy proceedings. Of these items, over 29,000 are included in the 32 years of source data covered in the 1955-1986 *SCI*. From this we see that about six times as many articles were published between 1955 and 1986 as in the previous 40 years. An online search of the *SCI* reveals that in 1986 alone *PNAS* published over 180 more articles than it did in 1985 (1,892 in 1985; 2,078 in 1986). In relation to other journals processed in the 1986 *Journal Citation Reports®* (*JCR®*) section of the *SCI*, *PNAS* ranks eighth in the total number of source items published in 1984 and 1985. This is significant because, while other journals publish letters, book reviews, and other types of documents, which are counted as source items in the *JCR*, Zwanzig says that "more than 99 percent of the items published in *PNAS* are research articles."[15]

PNAS articles are also frequently cited. In 1986 the journal accumulated more than 143,000 citations, ranking it third in the number of citations in the 1955-1986 *SCI*. Only the *Journal of Biological Chemistry* and *Nature* were cited more often (158,553 and 147,048, respectively).

PNAS Long-Term Impact

Another way to gauge the relative influence of a journal is to calculate its citation impact. The 1986 impact factor reflects the average number of 1986 citations received by 1984 and 1985 articles published in the journal. For 1986 the *PNAS* impact of 9.2 ranks it 26th among the 7,000 journals processed by the Institute for Scientific Information®. Many of the journals that rank ahead of *PNAS* are review journals. These journals typically achieve higher impacts than journals reporting mainly original research. Among multidisciplinary journals, *PNAS* ranks third. Both *Science* and *Nature* rank ahead of *PNAS*, with impacts of 12.4 and 15.3, respectively.

By calculating the impact for *PNAS* over a six-year period, we can get a longer-term perspective. We determined the impact by tallying the number of 1981-1986 citations to *PNAS* articles that were published in 1981. Its six-year impact is 44.42 cites per article, an impressive figure considering that the impact of the average article covered in the *SCI* during the same period is probably less than 8. (The latter figure is an estimate based on the statistical data reported in the introduction to the *SCI Source Index* each year.) As these figures show, *PNAS* has over five times the long-term impact of the average journal in the *SCI*.

The Bibliography

A list of classic papers identified on a year-by-year basis contains papers that vary widely in the number of citations received. The citations for Bibliography 1 range from 202 to over 5,800 cites. The 1979 paper by Harry Towbin and Julian Gordon, Friedrich Miescher Institute, Basel, Switzerland, and Theophil Staehelin, Hoffmann-La Roche Pharmaceutical Research Department, Basel, is the most-cited *PNAS* article in 1979 and of all *PNAS* papers in the 1955-1986 *SCI*, with over 5,800 citations. The paper discusses a method for the "Electrophoretic transfer of proteins from polyacrylamide gels to nitrocellulose sheets." This paper and hundreds of others published in *PNAS* qualify as *Citation Classics®*.

In contrast, the paper by George M. Church and Walter Gilbert, Biological Laboratories, Harvard University, Cambridge, Massachusetts, which discusses determining DNA sequences from genomic DNA, received only 202 citations, but it is the most-cited 1984 *PNAS* paper. It is included in Bibliography 1. While this paper may one day qualify as a *Citation Classic*, it has not yet had sufficient time to accumulate the level of citations for this designation. And as Table 1 shows, over 1,150 *PNAS* papers, or 13 percent, were cited 200 or more times in the 1955-1986 *SCI*. In comparison, only 8 percent of the entire *SCI* file was cited 200 or more times.

A quick glance at Bibliography 1 reveals that the majority of papers discuss topics in biochemistry and genetics. A few other papers are in related life-sciences specialties like immunology and cell biology. The one physical-sciences paper in Bibliography 1 is on "The optical rotatory dispersion of simple polypeptides" by the late William Moffitt, Department of Chemistry, Harvard, and Jen T. Yang, University of California, San Francisco. The paper gives an equation for identifying whether spiral-shaped proteins, or alpha helices, wind in a right- or left-handed direction by determining how they rotate a plane of polarized light.

According to Yang's 1985 *Citation Classic* commentary, this highly cited paper

> gave a means of detecting and, to some extent quantifying, α-helix in proteins in solution. It reassured the X-ray crystallographers that their structural inferences about right-handed helices were correct and persisted in solution. Most of all, perhaps, it renewed our interest in the development of new methodology for the study of chiroptical phenomena...of proteins, and later nucleic acids, and with it opened up a whole new avenue of biophysical inquiry.[16]

To date, 13 other papers of the 50 in the Bibliography are the subjects of *Classic* commentaries.

Table 1: Comparison of 1955-1986 citation distributions for the *Proceedings of the National Academy of Sciences of the United States of America* (*PNAS*) and for all cited items indexed in the 1955-1986 *SCI*®. The number and percentage of *PNAS* and *SCI* articles falling within each range are shown. The percentage, which is indicated by parentheses, represents the portion of articles out of the total number of items receiving 50 or more cites.

Citation Range	*PNAS*	1955-1986 *SCI*
≥700	68 (0.8)	2,411 (0.6)
500-699	93 (1.0)	2,463 (0.6)
400-499	103 (1.2)	2,864 (0.7)
300-399	236 (2.6)	6,445 (1.6)
250-299	248 (2.8)	6,497 (1.6)
200-299	415 (4.6)	11,655 (2.9)
150-199	791 (8.8)	24,931 (6.1)
100-149	1,910 (21.2)	66,761 (16.4)
75-99	1,921 (21.4)	84,169 (20.7)
50-74	3,205 (35.7)	198,548 (48.8)

Author and Institutional Information

Six Nobel laureates appear in Bibliography 1. Four have been honored for their work in chemistry. Christian Anfinsen, now at Johns Hopkins University, Baltimore, Maryland, was awarded the 1972 prize for his work on ribonuclease. In 1980 Paul Berg, Stanford University School of Medicine, California, shared the Nobel Prize with Gilbert and Frederick Sanger, Laboratory of Molecular Biology, Medical Research Council, Cambridge, UK. Berg was honored for his work on the biochemistry of nucleic acids, and Gilbert and Sanger were recognized for their work on base sequencing of nucleic acids. Sanger also won the 1958 Nobel Prize for his work on protein structure.

Two authors in the Bibliography won Nobel Prizes in physiology or medicine. The 1968 prize was jointly awarded to Marshall W. Nirenberg, National Institutes of Health (NIH), Bethesda; Har Gobind Khorana, University of Wisconsin, Madison; and Robert W. Holley, Cornell University, Ithaca, New York, for their work on the genetic code and protein synthesis. In 1982 Bengt I. Samuelsson, Karolinska Institute, Stockholm, Sweden, shared the award with Sune K. Bergström, also of the Karolinska Institute, and John R. Vane, Wellcome Research Laboratories, Beckenham, UK, for their work on prostaglandins. One of our 1984 essays discussed the impact of their research.[17]

Table 2: Geographic areas represented by the institutional affiliations given by authors in Bibliography 1, listed in descending order of the number of papers produced (column A). B = number of papers coauthored with researchers affiliated with institutions in other countries. C = national locations of institutions listed by coauthors.

Country		A	B	C
United States		47	1	France
California	16			
Maryland	7			
Massachusetts	7			
New York	7			
Colorado	3			
Connecticut	2			
Washington	2			
Illinois	1			
Missouri	1			
North Carolina	1			
Ohio	1			
Pennsylvania	1			
Tennessee	1			
Australia		1		
France		1	1	US
Sweden		1		
Switzerland		1		
UK		1		

It is not surprising that a large number of authors in the Bibliography have been elected to NAS membership before or after publishing in the *Proceedings*. By the same token, many have received other distinguished awards besides the Nobel Prize. Some of their honors include the Albert Lasker Awards, Louisa Gross Horwitz Prize, Eli Lilly and Company Research Award in Microbiology and Immunology, Alfred P. Sloan, Jr. Medal, Hammer Prize in Cancer, and the Gairdner Foundation International Award of Merit.

The authors of the articles in Bibliography 1 are affiliated with 31 different institutions worldwide. Six countries are represented: Australia, France, Sweden, Switzerland, the UK, and the US. Table 2 lists the countries according to the number of papers appearing in Bibliography 1. Four institutions appear most frequently. The campuses of the University of California at Berkeley, San Diego, and San Francisco account for seven papers. Three of the five papers produced at Berkeley discuss mutagenicity testing and list biochemist and geneticist Bruce N. Ames, well known for his salmonella/mammalian-microsome mutagenicity test,[18] as first author or as coauthor with Joyce McCann and colleagues. The first volume of the *ISI Atlas of Science® : Pharmacology* identifies this test, called the Ames test, as "one of the most popular short-term assays for detecting mutagenicity and...for predicting carcinogenic potential in rodents and humans."[19]

Other institutional affiliations of authors listed in the Bibliography include the NIH and Stanford, with six papers each, and Harvard University and Medical School with five.

Conclusion

This concludes the first part of our analysis of most-cited *PNAS* papers. The papers listed in Bibliography 1, selected on a year-by-year basis, provide somewhat of a "historical" perspective on the journal, as compared with a list based on absolute citation counts. As we have seen, the Bibliography highlights a range of papers. Most are so highly cited that they automatically classify as *Citation Classics*. The others warrant closer attention because many other factors may account for their emergence as the most cited for a particular year.

In Part 2 of this essay we will identify a list of most-cited papers published in *PNAS* regardless of year, excluding those papers appearing in Part 1, and highlight the 1986 research fronts for both Bibliographies.

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5. **True F W.** *A history of the first half-century of the National Academy of Sciences 1863-1913.* Washington, DC: NAS, 1913. p. 204-5.
6. **Goldblum J.** Personal communication. 4 August 1987.
7. *National Academy of Sciences: constitution and bylaws. April 23, 1985.* Washington, DC: NAS, 1985. 58 p.
8. **Hofbauer M.** Personal communication. 12 May 1987.
9. National Academy of Sciences elects new members. *THE SCIENTIST* 18 May 1987. p. 29.
10. *National Academy of Sciences of the United States: membership listing. August 1, 1985.* Washington, DC: NAS, 1985. 119 p.
11. National Research Council—National Academy of Sciences—National Academy of Engineering—Institute of Medicine. (Gruber K, ed.) *Encyclopedia of associations.* Detroit, MI: Gale Research, 1987. Vol. 1, part 1. p. 607.
12. **Hale G E.** The *Proceedings* of the National Academy as a medium of publication. *Science* 41:815-7, 1915.
13. **Wilson E B.** Announcement. *Proc. Nat. Acad. Sci. USA* 1:i, 1915.
14. --------------. *History of the Proceedings of the National Academy of Sciences 1914-1963.* Washington, DC: NAS, 1966. 296 p.
15. **Zwanzig F.** Personal communication. 16 April 1987.
16. **Yang J T.** Citation Classic. Commentary on *Proc. Nat. Acad. Sci. USA* 42:596-603, 1956. *Current Contents/Physical, Chemical & Earth Sciences* 25(8):18, 25 February 1985 and *Current Contents/Engineering, Technology & Applied Sciences* 16(8):18, 25 February 1985.
17. **Garfield E.** The 1982 Nobel Prize in medicine recognizes the impact of prostaglandin research by S. K. Bergström, B. I. Samuelsson, and J. R. Vane. *Essays of an information scientist: the awards of science and other essays.* Philadelphia: ISI Press, 1985. Vol. 7. p. 77-86. (Reprinted from: *Current Contents* (12):3-12, 19 March 1984.)
18. **Ames B N, McCann J & Yamasaki E.** Methods for detecting carcinogens and mutagens with the salmonella/mammalian-microsome mutagenicity test. *Mutat. Res.* 31:347-64, 1975.
19. **Bartsch H & Malaveille C.** The Ames test. *ISI Atlas of Science: Pharmacology* 1(1):1-4, 1987.

Bibliography 1: Chronologic selection of most-cited articles published in the *Proceedings of the National Academy of Sciences of the United States of America,* 1955-1984, according to the 1955-1986 *SCI*®. The most-cited article from each year, 1955-1959 and 1980-1984, is listed along with the *two* most-cited papers from each year, 1960-1979. Asterisks (*) indicate articles with *Citation Classic*® commentaries. The issue number, year, and edition of *Current Contents*® in which these commentaries appeared are in parentheses. Daggers (†) indicate first authors who have authored or coauthored other *Citation Classic* commentaries. The issue number, year, and edition of *Current Contents* in which these commentaries appeared are in brackets. Research-front numbers are listed for those papers that are core to 1986 *SCI/SSCI*® research-front specialties.

Number of 1955-1986 *SCI* Citations	Bibliographic Data
1,412	†**Ames B N, Durston W E, Yamasaki E & Lee F D.** Carcinogens are mutagens: a simple test system for combining liver homogenates for activation and bacteria for detection. *Proc. Nat. Acad. Sci. USA* 70:2281-5, 1973. [12/84/LS]
3,311	**Aviv H & Leder P.** Purification of biologically active globin messenger RNA by chromatography on oligothymidylic acid-cellulose. *Proc. Nat. Acad. Sci. USA* 69:1408-12, 1972. 86-1382
683	*†**Boyce R P & Howard-Flanders P.** Release of ultraviolet light-induced thymine dimers from DNA in *E. coli* K-12. *Proc. Nat. Acad. Sci. USA* 51:293-300, 1964. (35/80/LS) [36/81/LS]
767	***Branton D.** Fracture faces of frozen membranes. *Proc. Nat. Acad. Sci. USA* 55:1048-56, 1966. (1/79/AB&ES)
1,025	**Chamberlin M & Berg P.** Deoxyribonucleic acid-directed synthesis of ribonucleic acid by an enzyme from *Escherichia coli. Proc. Nat. Acad. Sci. USA* 48:81-94, 1962.
202	**Church G M & Gilbert W.** Genomic sequencing. *Proc. Nat. Acad. Sci. USA* 81:1991-5, 1984.
1,601	***Clewell D B & Helinski D R.** Supercoiled circular DNA-protein complex in *Escherichia coli*: purification and induced conversion to an open circular DNA form. *Proc. Nat. Acad. Sci. USA* 62:1159-66, 1969. (8/83/LS)
1,546	**Cohen S N, Chang A C Y & Hsu L.** Nonchromosomal antibiotic resistance in bacteria: genetic transformation of *Escherichia coli* by R-factor DNA. *Proc. Nat. Acad. Sci. USA* 69:2110-4, 1972.

Number of 1955-1986 *SCI* Citations	Bibliographic Data
845	**Collett M S & Erikson R L.** Protein kinase activity associated with the avian sarcoma virus *src* gene product. *Proc. Nat. Acad. Sci. USA* 75:2021-4, 1978. 86-3403
1,110	†**Cuatrecasas P, Wilchek M & Anfinsen C B.** Selective enzyme purification by affinity chromatography. *Proc. Nat. Acad. Sci. USA* 61:636-43, 1968. [22/80/LS]
625	**David J R.** Delayed hypersensitivity *in vitro*: its mediation by cell-free substances formed by lymphoid cell-antigen interaction. *Proc. Nat. Acad. Sci. USA* 56:72-7, 1966.
777	**Davies G E & Stark G R.** Use of dimethyl suberimidate, a cross-linking reagent, in studying the subunit structure of oligomeric proteins. *Proc. Nat. Acad. Sci. USA* 66:651-6, 1970.
625	**Field A K, Tytell A A, Lampson G P & Hilleman M R.** Inducers of interferon and host resisters, II. Multistranded synthetic polynucleotide complexes. *Proc. Nat. Acad. Sci. USA* 58:1004-10, 1967. 86-3813
1,098	**Friend C, Scher W, Holland J G & Sato T.** Hemoglobin synthesis in murine virus-induced leukemic cells *in vitro*: stimulation of erythroid differentiation dimethyl sulfoxide. *Proc. Nat. Acad. Sci. USA* 68:378-82, 1971. 86-5699
4,325	**Gilman A G.** A protein binding assay for adenosine 3':5'-cyclic monophosphate. *Proc. Nat. Acad. Sci. USA* 67:305-12, 1970.
2,087	***Grunstein M & Hogness D S.** Colony hybridization: a method for the isolation of cloned DNAs that contain a specific gene. *Proc. Nat. Acad. Sci. USA* 72:3961-5, 1975. (19/86/LS)
644	**Ham R G.** Clonal growth of mammalian cells in a chemically defined, synthetic medium. *Proc. Nat. Acad. Sci. USA* 53:288-93, 1965.
1,187	***Hamberg M & Samuelsson B.** Prostaglandin endoperoxides. Novel transformations of arachidonic acid in human platelets. *Proc. Nat. Acad. Sci. USA* 71:3400-4, 1974. (48/84/LS) 86-1368
796	**Hinnen A, Hicks J B & Fink G R.** Transformation of yeast. *Proc. Nat. Acad. Sci. USA* 75:1929-33, 1978. 86-2158
519	***Hirota Y.** The effect of acridine dyes on mating type factors in *Escherichia coli*. *Proc. Nat. Acad. Sci. USA* 46:57-64, 1960. (50/83/LS)
563	**Hopp T P & Woods K R.** Prediction of protein antigenic determinants from amino acid sequences. *Proc. Nat. Acad. Sci. USA* 78:3824-8, 1981. 86-0757
832	*†**Huang R C & Bonner J.** Histone, a suppressor of chromosomal RNA synthesis. *Proc. Nat. Acad. Sci. USA* 48:1216-22, 1962. (12/78) [4/84/LS]
866	**Jensen E V, Suzuki T, Kawashima T, Stumpf W E, Jungblut P W & DeSombre E R.** A two-step mechanism for the interaction of estradiol with rat uterus. *Proc. Nat. Acad. Sci. USA* 59:632-8, 1968. 86-1851
905	***Kuo J F & Greengard P.** Cyclic nucleotide-dependent protein kinases, IV. Widespread occurrence of adenosine 3',5'-monophosphate-dependent protein kinase in various tissues and phyla of the animal kingdom. *Proc. Nat. Acad. Sci. USA* 64:1349-55, 1969. (16/83/LS)
659	**Li C H & Chung D.** Isolation and structure of an untriakontapeptide with opiate activity from camel pituitary glands. *Proc. Nat. Acad. Sci. USA* 73:1145-8, 1976.
1,054	†**Markert C L & Moller F.** Multiple forms of enzymes: tissue, ontogenetic, and species specific patterns. *Proc. Nat. Acad. Sci. USA* 45:753-63, 1959. [5/82/AB&ES] 86-3620
4,358	**Maxam A M & Gilbert W.** A new method for sequencing DNA. *Proc. Nat. Acad. Sci. USA* 74:560-4, 1977.
726	†**McCann J & Ames B N.** Detection of carcinogens as mutagens in the *Salmonella*/microsome test: assay of 300 chemicals: discussion. *Proc. Nat. Acad. Sci. USA* 73:950-4, 1976. [12/84/LS] 86-0746
2,071	†**McCann J, Choi E, Yamasaki E & Ames B N.** Detection of carcinogens as mutagens in the *Salmonella*/microsome test: assay of 300 chemicals. *Proc. Nat. Acad. Sci. USA* 72:5135-9, 1975. [12/84/LS] 86-0746
767	**Meselson M, Stahl F W & Vinograd J.** Equilibrium sedimentation of macromolecules in density gradients. *Proc. Nat. Acad. Sci. USA* 43:581-3, 1957.
858	*†**Moffitt W & Yang J T.** The optical rotatory dispersion of simple polypeptides. I. *Proc. Nat. Acad. Sci. USA* 42:596-603, 1956. (8/85/ET&AS; PC&ES) [42/82/PC&ES]
612	**Niedel J E, Kuhn L J & Vandenbark G R.** Phorbol diester receptor copurifies with protein kinase C. *Proc. Nat. Acad. Sci. USA* 80:36-40, 1983. 86-1983
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Chronologic Index: First author of each paper follows year of publication.

Year	First Author	Year	First Author	Year	First Author	Year	First Author
1955	Puck T T	1964	Boyce R P	1970	Davies G E	1976	Li C H
1956	Moffitt W		Setlow R B		Gilman A G		McCann J
1957	Meselson M	1965	Ham R G	1971	Friend C	1977	Maxam A M
1958	Spizizen J		Richardson C C		Sjogren H O		Sanger F
1959	Markert C L	1966	Branton D	1972	Aviv H	1978	Collett M S
1960	Hirota Y		David J R		Cohen S N		Hinnen A
	Rubin H	1967	Field A K	1973	Ames B N	1979	Towbin H
1961	Nirenberg M W		Radloff R		Shelanski M L		Wahl G M
	Novikoff A B	1968	Cuatrecasas P	1974	Hamberg M	1980	Thomas P S
1962	Chamberlin M		Jensen E V		Shine J	1981	Hopp T P
	Huang R C	1969	Clewell D B	1975	Grunstein M	1982	Taub R
1963	Osborn M J		Kuo J F		McCann J	1983	Niedel J E
	Warner J R					1984	Church G M