The 102 Most-Cited Life-Sciences Publications in the New 1945-1954 *Science Citation Index*. Part 1. Titles, Journals, and Research Fronts

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This two-part essay examines 102 highly cited papers and books in the life sciences, 1945-1954, based on the *Science Citation Index*® cumulation for that decade. This first part features the complete Bibliography of works, analysis of journals, and discussion of research fronts. The concluding section will discuss the five most-cited papers, along with some of the major trends, achievements, and researchers in the life sciences in the decade following World War II.

"Enough evidence, we consider, has now been assembled to show that penicillin is a new and effective type of chemotherapeutic agent, and possesses some properties unknown in any antibacterial substance hitherto described." So wrote the young English biochemist Edward P. Abraham, together with six colleagues at the Sir William Dunn School of Pathology, Oxford, UK, in a paper published in *The Lancet* in August 1941.

Among Abraham's co-authors were two overseas scientists then resident in Britain—the German-Jewish émigré biochemist Ernst Chain and the Australian pathologist Howard W. Florey. Four years later, Chain and Florey shared the Nobel Prize in physiology or medicine with the Scots bacteriologist Alexander Fleming for their development of penicillin as the first "wonder drug" capable of vanquishing formerly feared and horrendous infections. Working at St. Mary's Hospital, London, Fleming had described the antibacterial action of the antibiotic 12 years earlier. But it was the Oxford team's work, followed by production of the drug in the US, which marked the real start of a revolution in the treatment of communicable diseases.

Reflecting its resounding impact in the literature of medical science, the Oxford paper was cited over 400 times between 1945 and 1954, according to data compiled from the recently published *Science Citation Index*® (*SCI*®). That figure makes it one of the most heavily cited of all life-sciences papers for the decade 1945-1954. Subsequently it went on to be cited more than 120 additional times. Aside from papers devoted largely to innovations in experimental methods and behavior theory, its citation score was exceeded by only one other publication. This was the paper published in 1949 by the American physician Philip S. Hench and his co-workers at the Mayo Clinic in Rochester, Minnesota, which detailed the dramatic effects of injections of cortisone or ACTH (adrenocorticotrophic hormone, now known as corticotrophin or corticotropin) in victims of rheumatoid arthritis. Describing spectacular improvements within a few days, even in patients severely disabled by the disease, the Mayo report seemed to presage a revolution as far-reaching as that which was by then being catalysed by the arrival of penicillin.

The Mayo paper was cited on over 450 occasions between 1945 and 1954. In 1950, the Nobel Prize in physiology or medicine went to Hench, together with one of his fellow authors (the American biochemist Edward C. Kendall) and Tadeus Reichstein, a Polish-born chemist who was then head of the Institute of Organic Chemistry at the University of Basle in Switzerland. The award was given for "discoveries relating to the hormones of the adrenal cortex, their structure and biological effects." Although the benefits of cortisone and ACTH in any one patient proved to be temporary, the Mayo work (which originated with Hench's suspicions that increased steroid production

Table 1: The number of authors per paper for the life-sciences articles most cited in the 1945-1954 *SCI®* cumulation.

Number of Authors per Paper	Number of Papers
9	1
7	3
5	2
4	6
3	11
2	34
1	29

explained the frequent alleviation of chronic rheumatoid arthritis during pregnancy) was a major breakthrough in our understanding of hormone action.

Also appearing among the top 102 most-cited life-sciences papers and books for 1945-1954 is one on the physiological effects of cortisone and ACTH in humans, co-authored by Randall George Sprague, Hench, and co-workers, which achieved about 335 citations. Underlining the acute interest which was developing during that period in the adrenal hormones, their natural functions and therapeutic potential, the list includes no less than six other high-scoring publications on adrenal hormones. Two papers by George Widmer Thorn and colleagues, describing a clinical test for insufficiency of the adrenal cortex and the clinical value of cortisone and ACTH, were cited over 350 and 265 times respectively. One of Thorn's colleagues, A.G. Hills, was principal author of a report on changes induced by ACTH in circulating leukocytes, which received over 230 citations. Another, P.H. Forsham, with colleagues, achieved over 400 citations for a report on clinical aspects of ACTH. And M.A. Sayers was principal author of a paper describing a novel assay for ACTH which was cited about 275 times. One of its co-authors, G. Sayers, also wrote a major review of the adrenal cortex and homeostasis, which attracted about 270 citations.

The 1945-1954 Survey

The penicillin and corticosteroid highlights, together with other features which we

Table 2: The journals that published the papers listed in the Bibliography. The numbers in parentheses are the 1987 impact factors for the journals. (The 1987 *impact factor* equals the number of 1987 citations received by the 1985-1986 articles in a journal divided by the number of articles published by the journal during that same period.) Data were taken from the 1987 *JCR®*. The figures at the right indicate how many papers from each journal appear in the Bibliography.

Journal	Number of Papers
J. Biol. Chem. (6.37)	26
Biochem. J. (3.80)	9
Endocrinology (3.84)	6
Nature (15.00)	3
Proc. Soc. Exp. Biol. Med. (1.36)	3
Science (14.30)	3
Biochem. Z. (N/A)	2
Brit. J. Exp. Pathol. (1.01)	2
Bull. Johns Hopkins Hosp. (N/A)	2
*[1]Hoppe-Seylers Z. Physiol. Chem.	2
J. Amer. Chem. Soc. (4.32)	2
*[2]J. Clin. Endocrinol.	2
J. Clin. Invest. (7.07)	2
J. Exp. Med. (11.08)	2
Physiol. Rev. (10.98)	2
*[3]Advan. Enzymol.	1
Amer. J. Hyg. (N/A)	1
*[4]Arch. Biochem.	1
Arch. Intern. Med. (2.01)	1
Bacteriol. Rev. (N/A)	1
Blood (7.15)	1
Harvey Lect. (1.71)	1
*[5]Ind. Eng. Chem. Anal.	1
J. Amer. Med. Assn. (4.43)	1
J. Cell. Comp. Physiol. (3.07)	1
J. Gen. Physiol. (7.14)	1
J. Immunol. (6.48)	1
J. Pharmacol. Exp. Ther. (3.32)	1
Lancet (13.26)	1
*[6]Mikrochemie	1
N. Engl. J. Med. (19.32)	1
*[7]Proc. Staff Meet. Mayo Clin.	1
*[8]Trans. Faraday Soc.	1

*[1]Changed in 1985 to Biol. Chem. Hoppe-Seyler (2.09)

*[2]Changed in 1952 to J. Clin. Endocrinol. Metab. (4.08)

*[3]Changed in 1967 to Advan. Enzymol. Relat. Areas Mol. Biol. (20.29)

*[4]Changed in 1951 to Arch. Biochem. Biophys. (2.19)

*[5]Changed in 1947 to Anal. Chem. (3.33)

*[6]Merged with Mikrochim. Acta in 1938 to form *Mikrochem. Ver. Mikrochim. Acta*. Then changed back in 1953 to Mikrochim. Acta (0.38)

*[7]Changed in 1964 to Mayo Clin. Proc. (2.84)

*[8]Divided in 1972 into J. Chem. Soc. Faraday Trans. I (1.43) and J. Chem. Soc. Faraday Trans. II (1.44)

Table 3: The 1987 ISI® research fronts that include one of the 1945-1954 most-cited items appearing as core documents (the first author's name from the Bibliography appears in parentheses). No front includes more than one of the 1945-1954 most-cited items. A = total number of core documents. B = total number of citing papers published in 1987.

Number	Name	A	B
87-0181	Serial compound conditioning of the rabbit's nictitating-membrane response, latent inhibition, and associative structures in instrumental learning (See Hull)	19	244
87-0375	Potassium magnesium depletion, myocardial calcium paradox, and elevated serum immunoreactive parathyroid-hormone concentrations in hypomagnesemia (See Krebs)	34	382
87-1397	Molecular mechanisms, synthetic polypeptides, nucleic-acid strands, inorganic double helix, transform of atoms, DNA base pairs, and laboratory medicine (See Avery)	2	50
87-1435	Influenza-virus hemagglutinin, migratory waterfowls in San-in District, Western Japan, and monoclonal antibody-selected antigenic variants (See Salk)	8	118
87-1692	Glutathione S-transferase, putative preneoplastic lesions of rat liver, and altered foci in multistage hepatocarcinogenesis (See Hotchkiss)	25	537
87-3182	Renal cortical slices, ascending pyelonephritis in rats, newborn rabbits, sulfisoxazole disposition, lung lymph, neutral protease, and brush-border enzymes (See Bratton)	2	91
87-3269	Kinetics of circular DNA molecule digestion, single roots sigmoid model, and alternative representations for integrated biochemical systems (See Michaelis)	2	42
87-5825	Atrial natriuretic peptide, chronic aminonucleoside nephrosis, renal function in rats, and glomerular dynamics (See Smith)	3	94
87-6381	Murine circadian patterns, chronobiological analysis, and domesticated B6D2F1 mice (See Hench)	4	30
87-7917	Column cellulose hydrolysis reactor, inulinase activity, thermostable amylase, extracellular enzymes, and mesophilic methane sludge (See Nelson)	2	253

shall discuss later, emerged from a study of the *SCI* which at the very outset illustrated the strength of biomedical science during the period concerned. The original intention was to review the 250 papers and books, across all scientific disciplines, which were most heavily cited between 1945 and 1954 inclusive. But approximately 89 percent of those items proved to be devoted to life-sciences research. It was decided, therefore, to conduct two separate reviews, one focussed on about 100 publications in the life sciences and the other (which will appear in *Current Contents*® later this year) on about 50 physical-sciences publications. The present essay covers the 102 life-sciences items most heavily cited in 1945-1954, which have been derived from the original list of 250 publications.

The average number of citations for the 102 books and papers over the 10-year period was 335.8, and the median was 270. By comparison with today, the number of authors per paper was low (Table 1). Only 6 had five or more authors and 63 had two or less. Overall, there were 185 authors, and 223 "author occurrences." Two names appeared as principal or co-author on four different papers. One was Forsham, one of the cortisone investigators. The other was the American pioneer of what was then termed biological chemistry, Donald D. Van Slyke, whose many and varied investigations into diabetes, nephritis, enzyme action, and gases and electrolytes in the blood led him to develop several important investigative and diagnostic techniques. Van Slyke's most heavily cited paper, co-authored with J.M. Neill, describes the use of vacuum extraction and manometry to determine gases in solution (over 485 citations). Another of the four papers is a section in the second volume of *Quantitative Clinical Chemistry*, the monumental reference book which Van Slyke wrote with J.P. Peters (over 290 citations).

Thirty-three journals were represented in the list of publications, but six of them accounted for 58.1 percent of the journal papers (Table 2). The *Journal of Biological Chemistry* was well ahead of the others, with more than a quarter of the total. Eighty-one of the journal articles were written in English and five were in German. Sixteen books appeared in the list, 13 of them published in the US. Only 10 countries were represented—Austria, Belgium, Canada,

Denmark, Germany (pre-1949), the federal German republic (post-1949), Poland, Sweden, the UK, and the US. Fifty-three institutions are represented overall, six of them occurring five or more times. With 11 appearances each, Harvard Medical School and The Rockefeller Institute for Medical Research, New York (which has been known as The Rockefeller University since 1965), head the list.

Ten of the publications, including that by Hench and his colleagues, appear as core papers to the "research fronts" compiled by ISI® for 1987 (Table 3). Among the others is the classic 1944 paper by Oswald T. Avery and colleagues at The Rockefeller Institute on the substance (which proved to be DNA) that is responsible for the transformation of *Pneumococcus* bacteria (over 235 citations). Another is the 1932 paper in which the later Nobel laureate Hans A. Krebs and his assistant Kurt Henseleit described their meticulous charting of the ornithine cycle of urea synthesis (about 300 citations). Krebs and Henseleit worked at the University of Freiburg in Germany.

This first part of the essay on the 1945-1954 most-cited life-sciences papers and books has presented the list of most-cited items and the associated lists of journals and research fronts. In next week's essay, Part 2, the major life-sciences highlights of the decade will be discussed.

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The Most-Cited Life-Sciences Publications in the *SCI*, 1945-1954

The life-sciences papers or books most cited in the *SCI*® cumulation, 1945-1954, alphabetized by first author. Numbers following the bibliographic entry indicate the 1986 and 1987 *SCI/SSCI*® research fronts for which these are core publications. An asterisk (*) indicates that the item was the subject of a *Citation Classic*® commentary. The issue, year, and edition of the commentary follow the bibliographic reference. A = number of 1945-1954 citations. A dagger (†) indicates that the item has been previously identified in our essay on the 250 most-cited items from the 1955-1964 *SCI* cumulation. (See reference 1 above.)

A	Bibliographic Data
425	**Abraham E P, Chain E, Fletcher C M, Gardner A D, Heatley N G, Jennings M A & Florey H W.** Further observations on penicillin. *Lancet* 2:177-89, 1941.
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227	**Astwood E B.** The chemical nature of compounds which inhibit the function of the thyroid gland. *J. Pharmacol. Exp. Ther.* 78:79-89, 1943.
235	**Astwood E B, Sullivan J, Bissell A & Tyslowitz R.** Action of certain sulfonamides and of thiourea upon the function of the thyroid gland of the rat. *Endocrinology* 32:210-25, 1943.
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521	*†**Barker S B & Summerson W H.** The colorimetric determination of lactic acid in biological material. *J. Biol. Chem.* 138:535-54, 1941. 86-1770 (46/83/LS)
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