

# Current Comments®

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## *Citation Classics*®—From Obliteration to Immortality—And the Role of Autobiography in Reporting the Realities Behind High Impact Research

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Only a small fraction of scientists, even those of Nobel class, receive public recognition of their work, and, as the history of this unique editorial feature has demonstrated, delayed recognition by peers is not unusual. *Citation Classics*® have provided authors of highly cited papers the opportunity to reflect on the human and scientific issues that explain the way in which their papers were received by the scientific community. Most of these papers did not encounter significant resistance to being published. Others, however, were rejected even by leading journals but were later published elsewhere. Many were the result of doctoral research. A great deal of further investigation is necessary before one can generalize about high impact work.

By the end of 1993, close to 5,000 of the retrospective commentaries we call *Citation Classics*® will have been published in *Current Contents*® (CC®). As most readers of CC know, these personal vignettes are written by authors of highly cited papers and provide both researchers and laypeople with a behind-the-scenes look at science in the making. Starting in 1994, however, *Citation Classics* will no longer be published in CC due to editorial changes that will take effect in January. But I hope to continue *Citation Classics* in *The Scientist*® after changing the scope of the commentaries to reflect their inclusion in a news periodical.<sup>1</sup>

Of course, the 5,000 papers honored to date are only a fraction of the papers worthy of this distinction—even 10,000 commentaries would reflect less than one-tenth of 1 percent of the 15 million papers and books the Institute for Scientific Information® (ISI®) has processed in the past 40 years. And since even a biweekly newspaper for scientists cannot accommodate all the thousands of papers and books that are candidates for *Classic* status, I am also contemplating publishing a *Journal of Citation Classics* in print and/or electronic format.

### A Brief History

The creation of *Citation Classics* in 1977 was the result of my many encounters with Nobel-class scientists. Through these contacts I became aware that only a small fraction of scientists doing Nobel-quality research ever receive public recognition. I was driven to find a way to acknowledge these scientists as well as other “mediocre” researchers, as J. Ortega y Gasset called them. They are not necessarily of Nobel class, but their work provides the foundation for other scientists’ groundbreaking discoveries. Ortega y Gasset suggested this hypothesis in his 1932 book *The Revolt of the Masses*, stating that science is built on the contributions of thousands of creative individuals, not merely an elite group of highly visible persons.<sup>2</sup> In 1972 Jonathan and Steven Cole disputed the Ortega hypothesis in a paper published in *Science*.<sup>3</sup> Recently, however, in a book entitled *Making Science*, Steven Cole refuted some of the policy implications he had drawn from Ortega’s hypothesis.<sup>4</sup>

The very first *Citation Classic* commentary was published in CC on January 3,

1977.<sup>5</sup> It was written by Oliver H. Lowry, author of the most-cited paper ever, "Protein measurement with the Folin phenol reagent."<sup>6</sup> Lowry's 1951 work led the list of 500 most-cited papers cited in the literature from 1961 to 1975, the group of articles from which we had decided to select *Classics*. This list soon proved too narrow to identify all publications that deserved the *Classic* honor, however, since most were from the life sciences. For example, of the 52 *Classics* published in *CC*<sup>®</sup> in 1977, 37 were from this subject area alone.<sup>7</sup>

In 1979 we expanded our criteria to ensure that we included commentaries from authors of both books and papers in clinical medicine; applied and environmental biology; the physical, chemical, and earth sciences; technology and applied sciences; the social and behavioral sciences; and the arts and humanities. Citation levels of *Classics* in these fields tend to be lower than in the life sciences for various reasons. The size of the latter literature produces many more candidates. Consequently, a paper in engineering that receives only 100 citations over its lifetime may be a citation superstar in its field.

### Previous *Classic* Study

A *CC* study published in 1981<sup>7</sup> looked at the 728 *Citation Classics*<sup>®</sup> published from January 1977 to December 1980. Twenty-four countries were represented, based on the affiliations of the authors at the time they wrote their articles. The US led the list, accounting for over two-thirds of the papers, followed by the UK (93 papers), Canada (29), and Australia (19). The authors listed 250 different institutional addresses on their original works, but by the time they wrote their commentaries, their addresses had changed, increasing this number to 315. Most of the authors were affiliated with academic institutions, but government and industry were also amply represented. The various campuses of the University of California accounted for the

most papers—40—followed by the National Institutes of Health (NIH) with 25, the University of Wisconsin (24), Harvard University (22), and Bell Laboratories at Murray Hill and Holmdel (18). Other institutions with at least 10 papers included the different branches of the University of London, Johns Hopkins University and Hospital, Stanford University, the California Institute of Technology, Columbia University, and the Universities of Cambridge, Chicago, Illinois, Pennsylvania, and Washington (Seattle).

The 1981 study also noted that 302 of the original papers were single-author works, while 245 articles boasted two authors. In addition, the average age of each paper was 19 years, with most being works from the 1960s.

### Recent *Classic* Commentaries

Lately, we have identified a number of *Classic* papers and books published just in the last 15 years. Biologist Lynn Margulis of the University of Massachusetts, Amherst, recently welcomed the opportunity to discuss "the question that Darwin never answered: how do species originate?" in a commentary<sup>8</sup> on her 1981 book, *Symbiosis in Cell Evolution*,<sup>9</sup> which has been cited over 340 times. "*Symbiosis* itself," she says, "is merely protracted physical association of organisms who are members of different species. *Symbiogenesis* is the resulting evolutionary change that occurs by permanent integration of symbionts."<sup>8</sup> In 1993 Margulis revised her *Classic* book to support this statement further.

Two *New England Journal of Medicine* (*NEJM*) articles from the 1980s were also recently featured in *Citation Classics*. A 1985 *NEJM* paper on the development of immunotherapy for cancer<sup>10</sup> and its 1987 follow-up article<sup>11</sup> have each been cited over 1,000 times since their publication. Stephen A. Rosenberg, National Cancer Institute, talked about his involvement in the development of this therapy. An encounter

early in his surgical training with two cancer patients whose natural body defenses defeated the disease triggered the investigation. It was not until 1974, however, when he joined the staff at NIH, that he began attempting to reproduce this phenomenon in other patients. It took 10 years, but in 1984 Rosenberg and colleagues observed the first cancer regressions in humans treated by immunotherapy.<sup>12</sup> A subsequent study on 157 patients with metastatic cancer, for whom standard therapy had failed, was summarized in the 1987 follow-up paper.<sup>11</sup> Nine patients underwent complete regression of metastatic cancer. Twenty additional patients underwent at least a 50 percent reduction in their cancer. In his commentary, Rosenberg stated that the paper "firmly established that immunotherapy alone could lead to the regression of even bulky cancers in selected patients and stimulated research aimed at improving these immunotherapies."<sup>13</sup> An editorial that accompanied the paper's publication in *NEJM*, by John Durant, president of Fox Chase Cancer Center, Philadelphia, discussed the hope these findings fostered. "Perhaps," wrote Durant, "we are at the end of the beginning of the search for successful immunotherapy for cancer."<sup>13</sup>

### The Human Side of Science

One of the primary goals of *Citation Classics*® has been to present the human side of science while paying tribute to diverse advances in science and scholarship.<sup>7</sup> Authors of highly cited papers are invited to provide us with the story behind their research. For example, what prompted them to undertake a project? What obstacles did they encounter?—in short, the human and personal details rarely revealed in formal journal articles. They are also asked to mention any awards received as a result of their work on the *Citation Classic* paper—further peer confirmation of the importance as well as impact implied by citation analysis.

When scientists include these personal recollections in their commentaries, they are in effect writing a mini-autobiography of their work in a particular area. If the book can be considered the macro unit of thought—an idea that is extensively developed<sup>14</sup>—then the *Citation Classic* commentary can be regarded as a micro unit of self-reflection. Short autobiographical accounts, wherever they are published, should become de rigueur for every retiring scientist, to capture his or her unique perspective on a scientific specialty.

Michael Gottlieb's July 1993 *Citation Classic* commentary<sup>15</sup> is a good example of this type of mini-autobiographic report. When he was an "unknown" assistant professor at the University of California, Los Angeles (UCLA), Gottlieb collected several cases of what he thought was a new syndrome. He first talked to Arnold Relman, editor of *NEJM*, about publishing his findings—Relman suggested he publish a brief article about the syndrome in *MMWR—Morbidity and Mortality Weekly Report* while preparing a more extensive paper for publication in *NEJM*. The initial article in *MMWR* alerted the public to a new disease later identified as acquired immunodeficiency syndrome, or AIDS. The subsequent paper, published in *NEJM* on December 10, 1981,<sup>16</sup> described the symptoms of the disease, how it might be transmitted, and the possibility of a viral source. Gottlieb stated that publication of this paper "changed my life," and he went on to work in AIDS research and patient care. Yet, "despite my record of productivity in clinical research and community service," he wrote, "in 1987 I was denied tenure at UCLA. While deeply disappointed at the time, I have no regrets about my role in bringing AIDS to the attention of the scientific community and the general public."<sup>15</sup>

### Reference Tools

*Citation Classic* commentaries provide researchers and students of science with

behind-the-scenes information about scientific endeavors. In 1986, we collected these commentaries in seven volumes called *Contemporary Classics in Science*.<sup>17</sup> This series of books provides a handy reference for anybody interested in the human side of science. Libraries find them convenient since they rarely store back issues of *CC*®. As mentioned in a recent *CC* essay,<sup>18</sup> the commentaries these volumes contain would be even more accessible for researchers if they were accumulated on compact disc (CD-ROM).

Joshua Lederberg, Rockefeller University, New York, and I have discussed how this CD-ROM version could be used to search for *Citation Classic*® commentaries that indicated that the original manuscript was turned down by a prestigious journal. All that would be required would be the use of appropriate keywords, such as "turned down" and "rejected by." Obviously, the authors of these papers went on to publish their papers in other journals. But the fact that many of them mention this experience says something about the fallibility of editors and referees and the phenomenon of delayed recognition. But it does not support the notion that the system of peer review is completely out of order!

Juan Miguel Campanario, assistant professor at Universidad de Alcala de Henares, Madrid, Spain, recently looked at *Citation Classics* from this perspective. He reviewed 316 commentaries for any indication that the authors had experienced difficulty in publishing their *Classic* papers. He found that nearly 6 percent of the authors did encounter obstacles either in the research phase or during publication. One of these papers was coauthored by a Nobel Prize winner. Three others are the most cited for the journals in which they were published. Reasons cited for publication difficulties pertained to the presentation of innovative methods or theories, or new interpretations of previous data in the articles.<sup>19</sup>

Another study based on *Citation Classic* commentaries was reprinted in *CC* in August of this year.<sup>18</sup> It analyzed 56 commentaries written by both men and women (evenly divided) to determine gender differences that might have been encountered by the authors. A full-text CD-ROM version of all *Citation Classic* commentaries published to date might have made it easier for the author, Helen Astin, UCLA, to examine even more commentaries for her analysis.

### **Controversial Claims and Other Obstacles**

On occasion, I have experienced pangs of conscience about certain individuals who were inadvertently and unwittingly slighted when we invited a possibly undeserving author to write a commentary. Since only a fraction of these commentaries have been subject to traditional peer review, we cannot guarantee their authenticity. In some instances we have heard from authors of papers claiming they were the originators of certain ideas or methods described by *Citation Classic* authors. In these cases, we provided the dissenting scientists with the opportunity to write their own commentaries. Not infrequently, even coauthors may disagree as to who was mainly responsible for what the papers reported. Ideally, the commentary should be approved by all coauthors, but this isn't always feasible.

Some Nobel Prize winners have declined our requests to write commentaries, believing that adding 500 words to what has already been widely discussed in the press or Nobel lectures is superfluous. Yet, even in the landmark case of the 1953 Watson-Crick discovery of the double helix of DNA,<sup>20</sup> not everything has been said on this subject. The passage of time always provides a new perspective.

At times, the first author on a paper is unavailable or unable to write a commen-

tary on his or her highly cited paper. In these cases, we usually ask one of the co-authors to oblige. For example, Leonard Hayflick, University of California, San Francisco, recently discussed a 1962 paper on the identification of an agent associated with atypical pneumonia (PAP) that he wrote with first author Robert M. Chanock and M.F. Barile at NIH.<sup>21</sup> It was one of two articles<sup>21,22</sup> that reported the results of studies on this agent, a pleuropneumonia-like organism called mycoplasma, or PPLo. Hayflick noted that both papers appeared on the list of the 100 most-cited papers of the two million published in the basic biomedical sciences during the 1960s.<sup>23</sup> This evidence "supports the conventional wisdom that biologists do their best science when they are young," he says, "because we were never able to duplicate this citation feat in any subsequent decade. It is also a tribute to the freedom at that time to pursue interesting leads unfettered by preconceived expectations written into grant proposals."<sup>24</sup>

### Contributions to Science

As we prepare to end the era of *Citation Classics*® as published in CC®, I must reiterate my feeling that this feature has served the scientific community well. I often encounter individuals who thank me for the recognition they received, which,

too often, was the only public acknowledgment of their work at that time. A case in point is the *Citation Classic* commentary by Donald J. Cram, UCLA,<sup>25</sup> published in 1978. It was the first real recognition of his work in stereochemistry. Nine years later, Cram won the Nobel Prize in chemistry.

In conclusion, I cannot help but mention the irony of the very first *Citation Classic*, and the most-cited paper of all time, the Lowry method, about which I have already written an essay.<sup>26</sup> In 1992 this paper was explicitly cited yet another 8,000 times after having been cited over 200,000 times in the previous 40 years. The Lowry article is the bane of citation analysis, since it is the anomaly used by some who wish to offhandedly discredit citation analysis, scientometrics, and quantitative studies of science. Yet who can deny that the measurement of protein is one of the fundamental tools of modern biological science? Rather than succumb to obliteration by incorporation, where discoveries or ideas become so fully incorporated into canonical knowledge that their source is no longer cited or even alluded to,<sup>27-29</sup> the Lowry method has become an example of citation immortality.

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### REFERENCES

1. Garfield E. *The Scientist*® newspaper: seven years on the human and professional sides of science. *Current Contents*® (43):3-6, 25 October 1993.
2. Ortega y Gasset J. *The revolt of the masses*. New York: Norton, 1932. p. 84-5.
3. Cole J R & Cole S. The Ortega hypothesis. *Science* 178:368-75, 1972.
4. Cole S. *Making science*. Cambridge, MA: Harvard University Press, 1992. p. 217-26.
5. Lowry O H. *Citation Classic*®. Commentary on *J. Biol. Chem.* 193:265-75, 1951. *Current Contents* (1):7, 3 January 1977.
6. Lowry O H, Rosebrough N J, Farr A L & Randall R J. Protein measurement with the Folin phenol reagent. *J. Biol. Chem.* 193:265-75, 1951.
7. Garfield E. *Citation Classics*—four years of the human side of science. *Current Contents* 22:5-16, 1 June 1981. (Reprinted in: *Essays of an information scientist*. Philadelphia: ISI Press, 1983. Vol. 5. p. 123-34.)

(Continued)

8. **Margulis L.** The inheritance of acquired microbes. Citation Classic®. Commentary on *Symbiosis in cell evolution*. New York: Freeman, (1981) 1993. 452 p. *Current Contents®/Life Sciences* 36(16):9-10, 19 April 1993.
9. -----, *Symbiosis in cell evolution*. New York: Freeman, (1981) 1993. 452 p.
10. **Rosenberg S A, Lotze M T, Muul L M, Leitman S, Chang A E, Ettinghausen S E, Matory Y L, Skibber J M, Shiloni E, Vetto J T, Seipp C A, Simpson C & Reichert C M.** Observations on the systemic administration of autologous lymphokine-activated killer cells and recombinant interleukin-2 to patients with metastatic cancer. *N. Engl. J. Med.* 313:1485-92, 1985.
11. **Rosenberg S A, Lotze M T, Muul L M, Chang A E, Avis F P, Leitman S, Linehan W M, Robertson C N, Lee R E, Rubin J T, Seipp C A, Simpson C G & White D E.** A progress report on the treatment of 157 patients with advanced cancer using lymphokine-activated killer cells and interleukin-2 or high-dose interleukin-2 alone. *N. Engl. J. Med.* 316:889-97, 1987.
12. **Rosenberg S A.** The development of immunotherapy for cancer. Citation Classic. Commentary on *N. Engl. J. Med.* 313:1485-92, 1985. *Current Contents/Clinical Medicine* 21(16):8, 19 April 1993.
13. -----, The end of the beginning. Citation Classic. Commentary on *N. Engl. J. Med.* 316:889-97, 1987. *Current Contents/Clinical Medicine* 21(18):8, 3 May 1993.
14. Macro. (Grove P B, ed.) *Webster's third new international dictionary*. Springfield, MA: Merriam-Webster, 1981. p. 1354.
15. **Gottlieb M S.** AIDS: the discovery. Citation Classic. Commentary on *N. Engl. J. Med.* 305:1425-31, 1981. *Current Contents/Clinical Medicine* 21(30):8, 26 July 1993.
16. **Gottlieb M S, Schroff R, Schanker H M, Weisman J D, Fan P T, Wolf R A & Saxon A.** *Pneumocystis carinii* pneumonia and mucosal candidiasis in previously healthy homosexual men: evidence of a new acquired cellular immunodeficiency. *N. Engl. J. Med.* 305:1425-31, 1981.
17. **Garfield E, ed.** *Contemporary classics in science*. Philadelphia: ISI Press, 1986-1987. 7 vols.
18. -----, Using the *Citation Classic* database for science studies. Part 1. Helen Astin on gender differences in author productivity. *Current Contents* (33):3-10, 16 August 1993; and Part 2. Helen Astin on how men and women perceive their high impact works. *Current Contents* (35):5-11, 30 August 1993.
19. **Campanario J M.** Consolation for the scientist: sometimes it is hard to publish papers that are later highly cited. *Soc. Stud. Sci.* 23:342-62, 1993.
20. **Watson J D & Crick F H C.** Molecular structure of nucleic acids: a structure for deoxyribose nucleic acid. *Nature* 171:737-8, 1953.
21. **Chanock R M, Hayflick L & Barile M F.** Growth on artificial medium of an agent associated with atypical pneumonia and its identification as a PPLo. *Proc. Nat. Acad. Sci. USA* 48:41-9, 1962.
22. **Hayflick L.** Tissue cultures and mycoplasmas. *Texas Rep. Biol. Med.* 23(Supp.1):285-303, 1965.
23. **Garfield E.** Most-cited articles of the 1960s. 3. Preclinical basic research. *Current Contents* (5):5-13, 4 February 1980. (Reprinted in: *Essays of an information scientist*. Philadelphia: ISI Press, 1981. Vol. 4. p. 370-8.)
24. **Hayflick L.** Discovery of the first mycoplasma to cause a human disease. Citation Classic. Commentary on *Proc. Nat. Acad. Sci. USA* 48:41-9, 1962. *Current Contents/Life Sciences* 36(40):8, 4 October 1993.
25. **Cram D J.** Citation Classic. Commentary on *J. Amer. Chem. Soc.* 74:5825-35, 1952. *Current Contents* (11):13, 13 March 1978.
26. **Garfield E.** Citation frequency as a measure of research activity and performance. *Current Contents* (5):5-7, 31 January 1973. (Reprinted in: *Op. cit.*, 1977. Vol. 1. p. 406-8.)
27. **Merton R K.** *Social theory and social structure*. New York: Free Press, 1968. p. 28; 35.
28. **Garfield E.** The 'obliteration phenomenon' in science—and the advantage of being obliterated! *Current Contents* (51/52):5-7, 22 December 1975. (Reprinted in: *Ibid.* Vol. 2. p. 396-8.)
29. **Merton R K.** Foreword. (Garfield E.) *Citation indexing: its theory and application in science, technology, and humanities*. New York: Wiley, 1979. p. 7-11. (Reprinted by: Philadelphia: ISI Press™, 1983. p. v-ix.)