

# Current Comments®

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## *Contemporary Classics in the Life Sciences: An Autobiographical Feast*

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Since 1977 *Current Contents*® (CC®) has been publishing commentaries written by authors of highly cited papers and books, identified by data from the *Science Citation Index*® (SCI®) and the *Social Sciences Citation Index*® (SSCI®).<sup>1</sup> In their commentaries the authors describe how they developed and conducted their research. They frequently mention the work of coauthors and the help they received from other colleagues. Some recall obstacles they encountered, even rejection by journal editors of papers that subsequently became highly influential. The authors also speculate about why their papers or books received such extraordinary attention. Many mention that they were unaware of the large number of citations to their work. At ISI® we call their exceptional articles and monographs citation classics. Their *Citation Classics*® commentaries, in illuminating the behind-the-scenes dimensions of scientific investigation and discovery, offer researchers, students, and historians of science insights ordinarily not found in the pages of professional journals and scholarly monographs.

When we introduced this editorial feature to CC in 1977, the same commentary appeared in each of the CC editions.<sup>1</sup> Two years later we provided a separate *Citation Classic* commentary suited to the subject area covered by each edition.<sup>2</sup> In 1981 we added a second *Citation Classic* to each issue of

CC/*Life Sciences* (CC/LS) to trim a burgeoning backlog.<sup>3</sup> (CC/*Arts & Humanities* is at present the only edition of CC that does not include the *Citation Classics* feature. We hope to add it in the future.) Now, about nine years since their inception, we have published over 2,100 unique *Citation Classics* commentaries. I emphasize "unique" because many commentaries, especially those in the physical and engineering sciences, have been published in two editions of CC.

Many readers tell me what I myself know well: copies of CC have an uncanny way of disappearing. Either they get lost in offices, laboratories, or homes or are lent to colleagues or students who forget to return them. *Essays of an Information Scientist*, Volumes 1 to 7, collect my weekly "editorials" in a convenient form. But, until now, there has not been easy access to *Citation Classics* commentaries. We debated for some time the most convenient and appropriate way of providing this. For example, should our compilation be comprehensive or topical? It was decided to combine the advantages of both approaches. We are planning to reprint all commentaries in bound volumes, each dealing with different sets of fields. The initial offering will collect those published in CC/LS. After this, we will proceed to other volumes covering the remaining editions.

ISI Press® will publish the first volume of collected *Citation Classics* commentaries this month. The volume, entitled

*Contemporary Classics in the Life Sciences*, contains approximately 575 commentaries originally published in *CC/LS*. The commentaries are organized under three main headings and, under each heading, by specialized field: cell biology (including sections on electron microscopy, microbiology, immunology, virology and tissue culture, genetics, cell structure and function, physiology and pharmacology, and neurobiology); molecular biology (including sections on carbohydrates, lipids and related compounds, nucleic acids, proteins and amino acids, and enzymes); and physical and mathematical sciences (with sections on physical analysis and instrumentation, chemical analysis and preparative methods, and statistics). The contents of the volume are fully indexed by subject, author, and authors' institutional affiliations.

We have been most fortunate to enlist James T. Barrett, professor of microbiology, School of Medicine, University of Missouri, Columbia, to serve as editor of *Contemporary Classics in the Life Sciences*. Barrett is the author of more than 50 articles and two standard textbooks of immunology.<sup>4,5</sup> His 35 years as an experimental scientist qualify him very well indeed to organize the commentaries and to supply a mini-review for each specialized group. In these mini-reviews, Barrett discusses each *Citation Classic* within its specialty.

We will also publish a second volume of collected *Citation Classics* in February 1986. The volume, entitled *Contemporary Classics in Clinical Practice*, includes commentaries that have appeared in *CC/Clinical Practice*. The collection ought to find a wide audience among both medical researchers and practicing physicians. Information on this and other volumes will be reported as soon as details are available.

I have little doubt that researchers and teachers will find these collections stim-

ulating reading. In their journal articles and monographs, scientists typically speak rather formally in the detached voice of the third person to avoid anything less than scrupulous objectivity. We know that all too often this can cover up much that is not objective, even though it is presented unemotionally.<sup>6</sup> Our *Citation Classics* commentaries, however, give lively accounts of experimentation and discovery. Speaking in the first person about some of their most important work, some of the sharpest scientific minds at work today recall, in a highly personal manner, the blind alleys and the "eureka" moments. It is always refreshing to hear scientists discuss their work with such enthusiasm.

Moreover, the typical scientific journal article lacks an account of the intellectual genesis and gestation of a project. When results are expressed in this manner, as *faits accomplis*, the reader does not know the mental route taken by the scientist to arrive onto previously uncharted terrain.<sup>7</sup> For this reason, students as well as journalists and historiographers of science can use these commentaries to supplement, if not initiate, their reviews of important discoveries.

*Contemporary Classics in the Life Sciences* will allow students to retrace the footsteps of pacesetter researchers in fields large and small. Much is to be learned along these pathways. A student reading account after account of how a question arose, how the scientist formulated an experiment, and how the experiment turned out will be able to observe the work of the research scientist from a unique perspective. Of course, the mere collection of such commentaries cannot in itself explain the process of scientific discovery through experimentation. A spate of books and articles discuss this phenomenon systematically.<sup>8-16</sup> The value of *exempla*, however, should not be discounted. See especially the late Julius H. Comroe's *Retrospectroscope*:

*Insights into Medical Discovery*, which is filled with concrete examples of scientific discovery. In it, Comroe made a strong case for the value of basic research.<sup>17</sup>

I well remember that undergraduate and graduate study can be an intimidating experience. Yet, students may be surprised and perhaps encouraged to read how some of their own professors—often illustrious men and women of science—had episodes of frustration, doubt, rejection, and even failure. It is particularly noteworthy how frequently the quality of doggedness figured into their discoveries. I hope that students will derive inspiration and encouragement from these real-life accounts to persevere with their own novel ideas. It is, in short, a feast of autobiographies.

*Contemporary Classics in the Life Sciences* is a treasury of important research. But it is only a sampling from the larger number of publications we have identified as classics. It is extremely difficult to say how “representative” this sample is. One needn’t question the importance of the works we included; citation analysis has demonstrated their widespread influence. But it is necessary to emphasize that the omission of any paper does not signify that it is unimportant. I have noted previously that if we were to adopt a strict criterion of choosing only one citation classic for every 1,000 papers published, it might take us over 30 years to publish commentaries on all the eligible papers, in as much as some 10,000,000 papers have appeared since 1950.<sup>18</sup> Clearly, we have only scratched the surface.

Many readers have asked, skeptically I might add, “How do you choose that one-in-a-thousand paper?” Our use of citation frequency is by no means purely algorithmic. Initially, we work with a file of 300,000 papers and books that have been cited 50 or more times. Among

these, the number cited 300 or more times is relatively small. We could arbitrarily classify all of these as citation classics.

But failure to achieve this exact numerical threshold does not disqualify a work as a citation classic. Any absolute high threshold automatically establishes a bias against papers in smaller fields. For example, the average number of citations to a classic work in radio astronomy is much lower than the average for a large field such as biochemistry. This parallels the range of impacts we have calculated for journals in these fields. To reiterate, citation counts initially help us to identify or confirm that certain papers or books are candidates. Those with extraordinarily high counts are automatically accepted. Those with lower counts are evaluated with other factors in mind, such as date, journal, field, and so on.

Not unexpectedly, a large number of the most-cited papers are concentrated in high-impact journals such as *Nature*, *Science*, and the *Proceedings of the National Academy of Sciences*. In physics, the *Physical Review* and a few other journals dominate. In chemistry, it is the *Journal of the American Chemical Society* and a few others that prevail.<sup>19</sup> Foremost in medicine are the *New England Journal of Medicine*,<sup>20</sup> *The Lancet*,<sup>21</sup> and *Annals of Internal Medicine*.<sup>22</sup> Were we to rely solely on absolute citation counts, we might never identify classic papers published in lower-impact journals. To overcome this problem, we created a separate file for each journal ranked by frequency. If one assumes that a journal uniquely defines a “field,” then the list of most-cited papers for that journal will include many of the classics for that field. Indeed, we have found that many classics were published in the first volumes of a specialty journal associated with the emergence of the then new field.

Often, however, the classic paper for a new field has been published in a multidisciplinary journal. For example, the most-cited paper in a small specialty journal may have been cited only 50 times, whereas the primordial paper for the field may have appeared earlier in the *Proceedings of the Royal Society of London* and may have received 100 citations. We would first select the paper from the *Proceedings* (usually having an earlier publication date). We would later invite the author of the second paper to prepare a commentary. It is also not unusual for the same author to have written both papers. The primordial paper from the multidisciplinary journal may not come to our attention until the author has written the commentary, or it may become obvious from someone else's reference to it.

Along with analyses by citation thresholds, journals, and subjects, we often examine our data by institution or country. Furthermore, we welcome nominations from our readers of works they believe are classics in their fields. Thus, we use a flexible, composite, and, we hope, an intelligent procedure to identify citation classics. We are not led blindly by citation counts, although I suspect that many readers assume this is so.

The increased level of research and publication of the last 30 years provides another reason for our not depending solely on absolute citation counts. Papers published in 1955 have much less chance of being cited at a given threshold than papers published in 1975 (Table 1). About 240 papers from 1955 were cited 300 or more times, up to 1984, whereas about 340 papers from 1975 were cited at this level, this in a third of the time. Papers less than 10 years old that have already been cited over 300 times are indeed contemporary classics. They reflect the rapid pace of modern

**Table 1:** Citation-frequency distribution for articles published in 1955 and 1975 and cited in *SCI*<sup>®</sup> from year of publication to 1984.

Citation Frequency	1955	1975
≥ 300	240	340
200-299	280	520
150-199	320	790
100-149	920	2,300
50-99	4,000	10,600
25-49	9,000	27,400
15-24	11,200	36,500
10-14	11,800	40,000
5-9	29,100	93,200
2-4	83,300	224,900
1	223,800	521,100
<b>Total</b>	<b>373,960</b>	<b>957,650</b>

science. These data are, however, affected by many factors, not the least of which is our increased journal coverage over the years. That too is a function of growth in science. Our *SCI* file for 1955 contains 80,600 source items; the same file for 1975 contains 418,900 source items, a fivefold increase.

In the future, we expect to refine our selection process further as we increasingly rely on research-front data derived from co-citation analysis.<sup>23</sup> Analysis by research fronts provides a more sensitive classification of subjects than does citation analysis by journal. We are now developing co-citation cluster maps that cover a 10-year period. These maps will enable us to identify broad subject areas as well as smaller disciplines and the citation classics identified with these fields.

Some readers have asked whether previously unidentified citation classics would emerge if ISI's source-journal coverage were expanded. A small number probably would; however, the counts for the highly cited papers already identified would also increase. Here and there rankings might shift slightly. Since we are dealing with such large populations of papers and fields, it is inevitable that some key papers are

not identified. That is why we must introduce some peer judgment into the selection procedure, which, in turn, will allow us to include some papers that are best described as uncited or hardly cited classics. This is a special category of papers that warrants separate treatment.

Another factor that influences *Citation Classics* included to date is the ability or availability of some authors to write a commentary. One would think that the author of a book or paper singled out as a citation classic would take pleasure in this type of positive "review." One journal called it an award. Engineers and applied scientists often complain, as do mathematicians, that their work is not accorded adequate public recognition. They do not receive Nobel Prizes or other highly visible awards. But they are often among the most reticent contributors of commentaries we have encountered. They tell us they are too busy or too preoccupied. One would expect such a reaction from Nobel laureates. But, in fact, we have published dozens of commentaries by them. Their affirmative responses seem to support the saying, "If you want a job done, ask a busy person." Their cooperation also seems to indicate an appreciation of the impact these commentaries might have on students as models of discovery and of their importance for historians of science. Can it be that the immortals of science generally have a better sense of history than the rest of us?

We live in an age of big science and of select, highly visible scientists, such as

the Nobel Prize winners. While it is tempting to compare the awards of science to Oscars or other conspicuous awards, the public should recognize that there are few awards for the many best-supporting scientists. It is important for students and laity to realize that scientific knowledge is cumulative and represents the work of thousands of creative individuals, not just that of an elite group whose work is most publicly acclaimed. Although Nobelists are, as stated, well represented in our *Citation Classics* commentaries, they are of course a minority in the collection. For this reason, I believe that *Citation Classics* commentaries more nearly represent the range of creativity in the world of science. The advance of scientific knowledge cannot be tabulated by simply listing the achievements of its elite.

In publishing *Contemporary Classics in the Life Sciences* and other volumes in the series, we are extending our effort to recognize and promote the numerous examples of landmark research by thousands of men and women scientists, whose accomplishments might otherwise pass unheralded. Those in government charged with allocating public funds in support of basic research would do well to examine our volumes of collected *Citation Classics* and recognize in these pages the remarkable quantity of excellent scientific research. Were it not for adequate funding of these many and diverse projects, the great ideas conceived by these scientists of the first class might have been stillborn.

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