

# Current Comments®

EUGENE GARFIELD

INSTITUTE FOR SCIENTIFIC INFORMATION®  
3501 MARKET ST. PHILADELPHIA, PA 19104

## Scientific Biography—Contemporary Reflections on *The Excitement and Fascination of Science*

Number 5

January 29, 1990

Themes related to scientific biography are reviewed. In the reprint of Joshua Lederberg's introduction to a new volume in the Annual Reviews series on scientific biography, special mention is made of the following topics: the substantive content of science, the philosophy of science, science as a social institution, the relationship between science and the forces that shape individuals, and the history of science.

*Current Contents*® (*CC*®) readers know of my long-standing interest in scientific history and biography. Previous essays on delayed recognition in scientific discovery,<sup>1,2</sup> a historical perspective on biomedical engineering,<sup>3</sup> and my occasional profiles of highly cited scientists—two recent examples being Linus Pauling<sup>4</sup> and Eli Robins<sup>5</sup>—reflect this interest.

Another example of my interest in presenting the human side of science is the weekly series of *Citation Classic*® commentaries that have appeared in all editions of *CC* since 1977.<sup>6</sup> In a sense, these *Citation Classics* are thumbnail "autobiographies"—not of people, but of their highly cited papers. The *Citation Classic* authors describe the discovery of an idea, the contributions made by various individuals to developing the idea, the social and institutional influences that helped foster a breakthrough, the reaction of peers to the published paper, and so on. We have to date published well over 3,000 *Citation Classic* commentaries in *CC* and have reprinted many of these in seven volumes.<sup>7-13</sup>

Many of my essays in *CC* have been autobiographical. But my recent personal experience with science autobiography involved an oral history prepared at the request of the Arnold and Mabel Beckman Center for the History of Chemistry,

University of Pennsylvania, Philadelphia, under the direction of Arnold Thackray.<sup>14</sup> The account describes my background in basic science, the early history of my involvement in developing and applying citation indexing, the people and events in my life that influenced the directions my career took, and recollections of many personal relationships with other scientists.

More scientists today seem to be interested in writing personal accounts of their life and work. Francis H.C. Crick,<sup>15</sup> Arthur Kornberg,<sup>16</sup> and Salvador E. Luria<sup>17</sup> are only a few examples of eminent scientists who have recently published autobiographical reflections. These and other scientific autobiographies provide the specialist and layperson alike with enlightening, interesting, and often humorous insights into scientific discovery. They show us that science is not just an objective pursuit of knowledge but is fundamentally a human process influenced by personal ambition, professional competition, and a healthy desire for recognition.

Joshua Lederberg, president, The Rockefeller University, New York, has recently written a thoughtful and insightful presentation on scientific biography and the epicycles of scientific discovery, which is reprinted here. His article originally appeared as the introduction to Annual Reviews' third volume of scientific biography, entitled *The*

**Table 1: List of *Citation Classic*<sup>®</sup> authors who also contributed to the book *The Excitement and Fascination of Science*. A = *Current Contents (CC*<sup>®</sup>*)* volume number. B = issue number, year, and edition of CC in which the commentary appeared.**

Name	A	B
Konrad J. Bloch	10	24/1982/CP
Arvid Carlsson	22	49/1979/LS
Kenneth S. Cole	20	3/1980/PC&ES
Horace W. Davenport	11	14/1983/CP
Michael Evenari	17	47/1986/AB&ES
Norman E. Good	26	40/1983/LS
Gerhard Herzberg	23	13/1983/PC&ES
Joseph O. Hirschfelder	20	13/1989/ET&AS
A. L. Hodgkin	24	28/1981/LS
John H. Humphrey	29	25/1986/LS
Seymour S. Kety	24	39/1981/LS
Joshua Lederberg	30	33/1987/LS
Fritz Lipmann	23	46/1980/LS
Maclyn McCarty	28	50/1985/LS
Robert K. Merton	12	21/1980/S&BS
	18	32/1986/S&BS
Herschel K. Mitchell	12	22/1981/AB&ES
Linus Pauling	25	4/1985/PC&ES
Michael Sela	15	9/1987/CM
C. Ralph Stocking	13	18/1982/AB&ES
Hans H. Ussing	24	35/1981/LS
Bruno H. Zimm	19	27/1979/PC&ES

LS—Life Sciences; PC&ES—Physical, Chemical & Earth Sciences; AB&ES—Agriculture, Biology & Environmental Sciences; ET&AS—Engineering, Technology & Applied Sciences; CP—Clinical Practice; CM—Clinical Medicine. [CP 1979-1986, CM 1987-present.]

*Excitement and Fascination of Science: Reflections by Eminent Scientists*.<sup>18</sup> The previous volumes in this series appeared in 1965 and 1978. These volumes reprint prefatory chapters that were first published in the various bound annual editions of *Annual Reviews*.<sup>19,20</sup>

The third volume contains 109 autobiographical accounts by scientists from a wide variety of disciplines, from anthropology to toxicology. Twenty-one of these scientists have to date also authored *Citation Classic* commentaries for CC. They are listed in Table 1, which also shows the CC volume, year, and edition in which their commentaries appeared.

The contents pages of the two-part Annual Reviews monograph appear in the *Current Book Contents*<sup>®</sup> section of this CC edition. These chapters give us a privileged perspective on science by some of its more creative and brilliant practitioners. I'm sure readers will find the compilation not only inspiring and instructive, but incredibly informative.

\* \* \* \* \*

*My thanks to Peter Pesavento for his help in the preparation of this essay.* © 1990 ISI

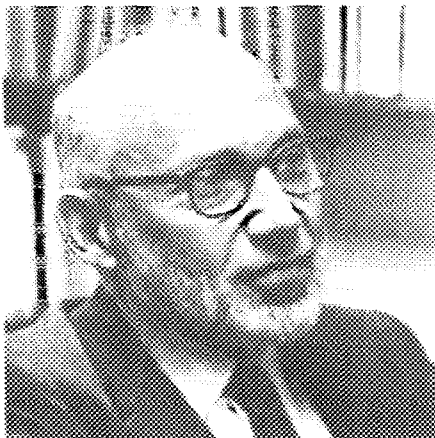
## REFERENCES

1. **Garfield E.** Premature discovery or delayed recognition—why? *Essays of an information scientist*. Philadelphia: ISI Press, 1981. Vol. 4. p. 488-93.
2. -----, Delayed recognition in scientific discovery: citation frequency analysis aids the search for case histories. *Current Contents* (23):3-9, 5 June 1989.
3. -----, Exploring the frontiers of biomedical engineering: an overview of historical and current considerations. *Op. cit.*, 1989. Vol. 10. p. 63-71.
4. -----, Linus Pauling: an appreciation of a world citizen-scientist and citation laureate. *Current Contents* (34):3-11, 21 August 1989.
5. -----, A tribute to Eli & Lee Robins—citation superstars. A citationist perspective on biological psychiatry. *Current Contents* (46):3-11, 13 November 1989.
6. -----, *Citation classics*—four years of the human side of science. *Op. cit.*, 1983. Vol. 5. p. 123-34.
7. **Barrett J T**, ed. *Contemporary classics in the life sciences. Volume 1: cell biology*. Philadelphia: ISI Press, 1986. 368 p.
8. -----, *Contemporary classics in the life sciences. Volume 2: the molecules of life*. Philadelphia: ISI Press, 1986. 282 p.
9. -----, *Contemporary classics in clinical medicine*. Philadelphia: ISI Press, 1986. 390 p.
10. **Thackray A**, comp. *Contemporary classics in physical, chemical, and earth sciences*. Philadelphia: ISI Press, 1986. 375 p.
11. -----, *Contemporary classics in engineering and applied science*. Philadelphia: ISI Press, 1986. 363 p.
12. **Barrett J T**, comp. *Contemporary classics in plant, animal, and environmental sciences*. Philadelphia: ISI Press, 1986. 371 p.
13. **Smelser N J**, comp. *Contemporary classics in the social and behavioral sciences*. Philadelphia: ISI Press, 1987. 361 p.
14. **Garfield E.** *Oral history*. (Transcript of an interview conducted by A. Thackray & J.L. Sturchio.) Philadelphia: Arnold and Mabel Beckman Center for the History of Chemistry, University of Pennsylvania, 16 November 1987. 46 p.

15. Crick F H C. *What mad pursuit: a personal view of scientific discovery*. New York: Basic, 1988. 182 p.
16. Kornberg A. *For the love of enzymes: the odyssey of a biochemist*. Cambridge, MA: Harvard University Press, 1989. 336 p.
17. Luria S E. *A slot machine, a broken test tube: an autobiography*. New York: Harper & Row, 1984. 228 p.
18. Lederberg J. Introduction. (Lederberg J, comp.) *The excitement and fascination of science: reflections by eminent scientists*. Palo Alto, CA: Annual Reviews, 1990. Vol. 3. Pt. 1. p. xvii-xxiv.
19. Luck J M, comp. *The excitement and fascination of science: a collection of autobiographical and philosophical essays*. Palo Alto, CA: Annual Reviews, 1965. Vol. 1. 566 p.
20. Gibson W C, comp. *The excitement and fascination of science: reflections by eminent scientists*. Palo Alto, CA: Annual Reviews, 1978. Vol. 2. 688 p.

---

Reproduced with permission from *The excitement and fascination of science*, Volume 3, Part 1, ©1990 by Annual Reviews Inc.



## INTRODUCTION: *Reflections on Scientific Biography*

Joshua Lederberg  
President  
The Rockefeller University

---

Accounts of the lives of scientists have enjoyed only a limited vogue in recent decades, both within the profession and in popular culture. Thus “what one does,” adduced to justify one’s findings, comprises the primary scientific literature, while “who one is” is omitted as a potential contaminant of objective scientific judgment. In science the personal life has been considered far less relevant to the search for truth than in more self-expressive fields such as literature and the arts. Hence tradition in scientific writing has discouraged use of personal pronouns and other manifestations of self.

Although folk heroes like Marie Curie and Albert Einstein have, by their unique achievements, made exceptional claims on popular interest, the conjunction of high scientific achievement, expository skill, and the time necessary for reflection and composition remains rare. Full-length autobiographies of genius, such as François Jacob’s recent book *The Statue Within*, are few and far between (5).<sup>1</sup> Even rarer are chronicles of workaday scientists, who produce the substance of most scientific advances (4).

---

1. Literary geniuses have often expressed themselves in autobiography, but we do not often find such practiced expository skill among scientists; and the problem of rapport with a broad readership on arcane subject matter is an additional grave hindrance. The knack of simplification is a gift. This truth and the fact that simplification must distort complex knowledge have deterred most scientists of genius from autobiography.

While the scientist's restraint from self-description may have helped to preserve the purity of the logic of justification, the indispensable critical function in science, it has also deprived us of insight into the personal and social processes that motivate discovery and pervade the scientific effort. We are left with narratives of chase, competition, and interpersonal stress rather than accounts of imagination gratified and cooperation achieved. Today's youngsters contemplating scientific careers indeed deserve more life-sized and sophisticated portraits of their role models than my generation had in de Kruif's *Microbe Hunters* (1926)—but also truer portraits than the melodrama that now makes the bestseller lists and electronic media. The prefatory chapters collected here provide an antidote to these extremes. Many are autobiographical, and these have an appeal far beyond the specialty interests of a given series, be it the *Annual Review of Genetics* or the *Annual Review of Astronomy and Astrophysics*.

This collection, Volume 3, which includes chapters that appeared originally from 1977 through 1987, embraces a broader range of subject matter than did Volumes 1 (1965) and 2 (1978).<sup>2</sup> But despite its breadth of coverage, Volume 3 includes only a large fraction of the prefatory chapters published during the period. Not included were some so technical (where, for example, “ $\Sigma$ ” appears more frequently than “I”) that our lay readers might have found them arcane. Others were excluded that address broad issues of great general interest but are not in the autobiographical mood of the present collection. Several *Annual Reviews* are not represented here at all, since some editorial committees do not invite chapters in this genre. Prefatory chapters in the *Annual Review of Psychology*, for example, are not autobiographical, the series coeditors having determined that the “History of Psychology as Represented in Autobiography” (14) is the more appropriate vehicle for such contributions. As another prefatory variant the *Annual Review of Phytopathology* has published numerous contributions on the history of the discipline.<sup>3</sup>

Arrayed in Volume 3, then, are more than five score chapters that hew close to the central line of autobiographical memoir. Their authors were selected by their peers on the editorial committees of the various *Annual Reviews* as certified successes in their fields who had worthy stories to tell. Indeed they comprise a sample of the highest achievers, and they write about the scientific issues of greatest interest to the readers of the *Annual Reviews*. (Few of these authors would have cared to write detailed “confessions” in the style of a Rousseau, Proust, Sartre, or Jacob.) Originally offered without a thought about eventual republication for a wider audience, these memoirs have much to communicate both to scientists and to the broader public.

---

2. An index to all prefatory chapters published in all of the *Annual Reviews* through 1987, whether included in these collections or not, appears as an appendix to this volume.

3. Although not reprinted here, those chapters are all recorded in the appendix to the present volume, as are the chapters in *The History of Entomology*, a volume published in 1973 by Annual Reviews Inc. and now out of print.

---

These two thousand and more pages of autobiographical reflections could provide the raw material for a doctoral dissertation's worth of analysis, whose annotations might in turn fill a volume (3). Since my present purpose is to assess what the genre has to offer, I will only suggest a few generalizations about scientific biography. To the questions "Why write it?" and "Why read it?" I respond that it can offer at least five sorts of perspective:

- on the substantive content of science;
- on the philosophy of science as a process of discovery and verification;
- on science as a social institution;
- on the relationship between science and the forces that shape human individuals; and
- on the history of science.

### *The Substance of Science*

Biography engages public interest in a body of scientific work. Contemporary books like those of S. E. Luria (15), Maclyn McCarty (16), and Arthur Kornberg (11) may attract audiences far wider than the one with the background to assimilate the authors' original research. But biography as a way of teaching science is often frustrated by the scarcity of luminaries: There are few figures whose work, like Einstein's (19), can characterize an entire field. Collective biographies, like Kevles's on the physicists and the geneticists (9,10), Rhodes's on the atomic bomb (20) and Judson's on molecular biology (6), are one means of broadening the vista. The autobiographical memoir that focuses on a set of scientific issues as much as on the personality of the author may also help to fill the gaps among portraits of giants. Most of the accounts in this volume well serve the latter purpose. In fact many of the individual memoirs in the present volume do inadvertently reinforce their neighbors.

For scientific substance, our memoirs will be more helpful in enlarging than in initiating an understanding of a field.

### *The Philosophy of Science*

Very little of what is published on the philosophy of science is informed by firsthand encounter with laboratory investigation (and vice versa). A number of this volume's memoirs treat, more or less explicitly, the logic (and mathematics) of verification. The logic of discovery, if there is one, is the implicit agenda of most of them. Such an agenda can be difficult to trace, of course, when the objects of discovery are the province of a scientific specialty.

In Figure 1 (*overleaf*), I posit a rough guide to the steps, or rather interlocking cycles, of cognitive method in scientific discovery. The nodes are not always sequential; each must be drawn with return arrows — regressions to prior stages in response to new insights, data, opportunities, and constraints. The figure is drawn from introspection, not from analysis of the memoirs collected in this volume, which may or may not corroborate this

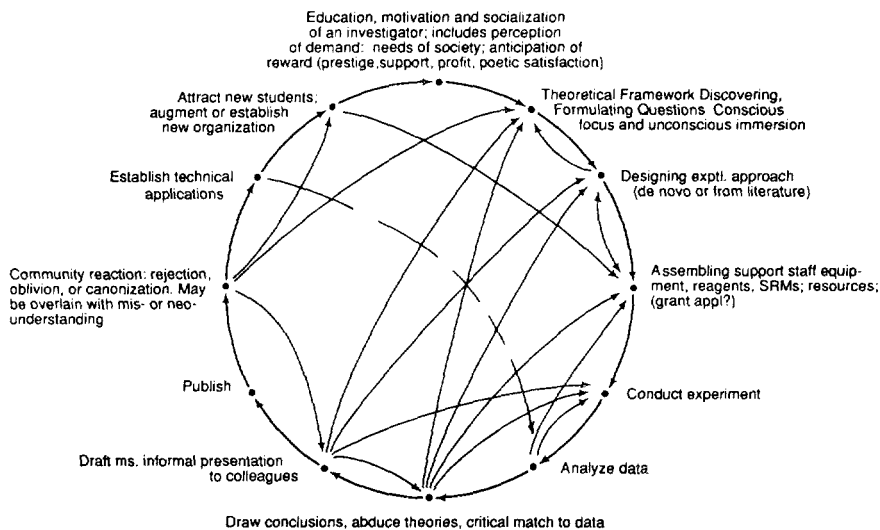
conventional model. The claims of the grant-writer notwithstanding, scientific progress and its translation to the fruits of technology are far from simple linear processes. In research practice, the reverse loopings far outnumber the incremental steps. Contact with other scientists and their ideas, by personal encounter, the literature, bibliographic retrieval systems, *Annual Reviews*, is more pervasive than is exhibited in this diagram or written in the memoirs. Rarely do scientists recall how they made such contacts (2).

### *The Sociology of Science*

Missing from most primary literature in science are all but the faintest clues about the social context of discovery—how the scientific community is shaped by its operating norms and institutions, as well as by its fraternal and intergenerational networks (8). The proliferation of multiple authorship does suggest imperatives of collaboration, especially as the technology of experimentation becomes more specialized; and appended acknowledgments of the funding of ever more costly instruments give some hint of the dependence of science on the larger community. Likewise, the application of science to the search for solutions to many of humankind’s gravest problems manifests the institution’s social aspect.

Biography depicts directly the personal relationships among scientists, their mutual debts, their etiquettes, sometimes their jealousies and transgressions. Rarely among our pages, however, do we find signs of a competition as intense as that attributed by Watson to the race for “The Double Helix.” Perhaps the stakes of that race are matched only a few times in a century, so

## **Epicycles of Scientific Discovery**



that such a chase engenders a ferocity foreign to even the highest accomplishments of less notoriety. For the most part our authors have not attained, nor did they seek, the degree of public attention that warrants full-length biography. Their personalities, though less flamboyant than those celebrated in the daily headlines, are far more typical of practicing scientists.

Enmeshed in society, scientists may also find themselves with extra-scientific responsibilities and roles, though each of these is grounded in the fundamental one of discovering and telling the truth (13).

Our chapters abound in examples of the researcher doubling as teacher and publicist; organizer and manager; inventor, agent of technology transfer, and developer of useful applications; adviser to government or industry; prophet; and paragon. Caveat: perhaps those who write are a socially and self-selected sample; others may insist on staying at the bench to the exclusion of all else.

An elucidation of the social conditions of science is the province of an authentic discipline of social science (1,17). Such an understanding is indispensable in the management of the institutions of science, in the optimal search for and nurture of creative talent, and in the most socially beneficial allocation of scarce resources. If the confidence and support of the larger society are to be sustained, the public must understand how in the practice of science a system of reward for personal ambition is melded with, and only rarely contravenes, the search for truth.

### *The Psychology of the Scientist*

Among the first questions addressed by biography is often the choice of career: “Why do science?” With varying explicitness, our authors provide answers that involve:

- curiosity—the exercise of intellect and of aesthetic taste
- virtuosity—the prestige and self-satisfaction they derive from the practice of extraordinary skill
- power—influence and vanity — the fruits of “success”
- illumination—compulsion approaching the religious, associated with peak discovery
- service—in reaching other minds and in generating useful knowledge

The scientific life is hardly devoid of drama, but one may have to plumb a depth of circumstantial detail — nuances of personality and of science — to become aware of it. Equipped with introspection, however, the reader may readily recognize in these chapters a substantial number of stresses and contradictions in the scientific life (3,12,18), conflicts between sets of norms:

- imagination vs critical rigor
- iconoclasm vs respect for established truth

- arrogant audacity toward nature vs humility and generosity toward colleagues
- efficient specialization vs broad interest
- experimentation vs reflection, reading, speculation
- ambition vs sharing of ideas and tools
- celerity (priority) vs deliberateness (reliability)

Broadly speaking, these match the Dionysian and Apollonian ideals.

Why does the scientist write a self-advertisement, an *apologia pro vita sua*? Perhaps most of all to gain self-understanding. The most useful public function may be to inspire a new generation to enter a scientific career, and to exemplify the highest ideals of the profession.

### *History*

No contemporary scientist has worked and thought in a vacuum; the presentation and solution of problems are part of a history of ideas. The greatest discontinuities pose the greatest challenge to understanding. Why are some ideas so “premature” as to meet fatal resistance when first published? One thinks of Gregor Mendel, whose far-reaching experiments were ignored during his lifetime, as an uncontroversial example.

Because the scientific method in practical use is so complex, the course of science is subject to numerous noncognitive, social influences. We know little, for example, about what informs the creative imagination (7). In a review of a prior discovery account of my own, Harriet Zuckerman and I suggested that discovery might sometimes be “postmature” (22). (That such terms as “pre-” and “postmature” imply a preordained rhythm of discovery we are well aware.) We see a “postmature” discovery as one deterred by a hindrance at one step in the cycle (see Figure 1) prior to publication, most of the other ingredients being in place. A discovery resisted in this way then deprives the intellectual milieu of precursors for putative subsequent discoveries. We acknowledge that the hindrance may lie in the creative faculty itself; but retrospection often reveals so many close calls that we wonder whether some particular impediment could have been relieved at an earlier stage. Clearly the social system of science, with its roots in the selection and nurturing of talent, does not function perfectly, without friction or dissipation. This is no surprise, since its processes remain barely examined (17).

Informative for the historian of science these pages likewise comprise social and political history (21). This and prior volumes of *The Excitement and Fascination of Science* are replete with world events. The migrations from the Europe of the Tsars and later of Hitler, the mobilizations of World War II, and the postwar Red scare blacklists are recurrent themes. The extra-scientific preoccupations of many of our writers are touched even more deeply by that historical context than are the details of their scientific output.



The various brief contributions in Volume 3 rarely answer all the questions implied in this introduction. However, authors of future memoirs (and, happily, of most of the present ones) are currently thriving. We may hope for further work touching on these themes.

---

#### Literature Cited

1. Barber B., Hirsch, W., eds. 1962. *The Sociology of Science*. New York: Free Press
  2. Durbin, P. T., ed. 1980. *A Guide to the Culture of Science, Technology and Medicine*. New York: Free Press
  3. Eiduson, B. T., Beckman, L., eds. 1973. *Science as a Career Choice: Theoretical and Empirical Studies*. New York: Russell Sage Foundation
  4. Goodfield, J. G. 1981. *An Imagined World. A Story of Scientific Discovery*. New York: Harper & Row
  5. Jacob, F. 1988. *The Statue Within*. Transl. Franklin Philip. New York: Basic Books
  6. Judson, H. F. 1979. *The Eighth Day of Creation*. New York: Simon & Schuster
  7. Judson, H. F. 1980. *The Search for Solutions*. New York: Holt, Rinehart & Winston
  8. Kanigel, R. 1986. *Apprentice to Genius: The Making of a Scientific Dynasty*. New York: Macmillan
  9. Kevles, D. J. 1978. *The Physicists: The History of a Scientific Community in Modern America*. New York: Knopf
  10. Kevles, D. J. 1985. *In the Name of Eugenics: Genetics and the Uses of Human Heredity*. New York: Knopf
  11. Kornberg, A. 1989. *For the Love of Enzymes: The Odyssey of a Biochemist*. Cambridge: Harvard Univ. Press
  12. Kubic, L. S. 1953-54. Unsolved problems of the scientific career. *Am. Scientist* 41:596-613; 42:104-12. Also Reprinted in Ref. 1, pp. 291-29.
  13. Lederberg, J. 1989. The social function of the scientist. In *The Social Function of Science 1989*, ed. H. Steiner. Berlin: Akademie-Verlag. In press
  14. Lindzey, G., ed. 1989. *A History of Psychology in Autobiography*, Vol. III. Stanford: Stanford Univ. Press
  15. Luria, S. E. 1984. *A Slot Machine, a Broken Test Tube: An Autobiography*. New York: Harper & Row
  16. McCarty, M. 1985. *The Transformation Principle: Discovering that Genes are Made of DNA*. New York: Norton
  17. Merton, R. K. 1973. *The Sociology of Science. Theoretical and Empirical Investigations*. Chicago: Univ. Chicago Press
  18. Merton, R. K. 1976. The ambivalence of scientists. In *Sociological Ambivalence and Other Essays*, pp. 32-55. New York: Free Press
  19. Pais, A. 1982. *'Subtle is the Lord...': The Science and Life of Albert Einstein*. Oxford: Oxford Univ. Press
  20. Rhodes, R. 1986. *The Making of the Atomic Bomb*. New York: Simon & Schuster
  21. Russell, N. 1988. Towards a history of biology in the twentieth century: directed autobiographies as historical sources. *Brit. J. Hist. Sci.* 21:77-89
  22. Zuckerman, H. A., Lederberg, J. 1986. Forty years of genetic recombination in bacteria. Postmature scientific discovery? *Nature* 327:629-31
-

**Error processing SSI file '/perkin/Garfield/garfield.html'**