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The Awards of Science: Beyond the Nobel Prize. Part 2. The Winners and Their Most-Cited Papers

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In part one of this essay,¹ we provided a list of 52 prizes described as "non-Nobel" awards. The reason for choosing this term was somewhat tongue-in-cheek. The Nobel Prize has attained such a position of prestige with both scientists and the general public that other scientific awards seem to pale in comparison. This generalization is confirmed by the public's attitude toward Nobel Prize winners. Like movie stars, Nobelists are often idolized and consulted by the press on topics for which they have little training. Nobelist Rosalyn Yalow,² Veterans Administration Research Center, Bronx, New York, whose name is almost synonymous with radioimmunoassay, notes, "The Nobel Prize gives you the opportunity to make a fool of yourself in public."³

Although the Nobel is the most coveted and visible scientific award, hundreds of other prestigious awards recognize excellence in science. Several of these, including the Fields Medal in mathematics and the Holger Crafoord Prizes in mathematics, astronomy, biological science, geological science, and arthritis research, are in a sense "Nobels" for fields the Nobel does not honor. Others are what Harriet Zuckerman, Columbia University, New York, terms "premonitory prizes," which gauge their success by the extent to which they anticipate the Nobel.⁴ The Lasker Awards are probably the best-known example. For-

ty Lasker winners have won the Nobel—39 of them before and 1 after winning the Nobel,⁵ according to Alice Fordyce, director, Albert Lasker Medical Research Awards.

Another award that has often anticipated the Nobel is the Gairdner Foundation Award. Sally-Anne Hrica, executive director, Gairdner Foundation, notes that 27 Gairdner winners went on to win the Nobel, while 2 received the Gairdner after the Nobel.⁶ Recently, the John Scott Award⁷ of Philadelphia was given to Georges J.F. Köhler, Basel Institute of Immunology, and Cesar Milstein, Medical Research Council's Laboratory, Cambridge. This selection was made almost a year before the Nobel Prize announcements.

In the first part of this study, we identified the names and sponsors of more than 50 non-Nobel awards. The individuals who received these as well as three other awards are discussed below. One of these additional prizes is the Ernest Jung-Preis für Medizin, awarded annually since 1976 by Ernest Jung Stiftung in Hamburg, Federal Republic of Germany. This prize carries an honorarium of 100,000 to 300,000 DM (\$42,000 to \$126,000) for pioneering research that has been translated into clinical practice. The Passano Award for medical research is administered by the Passano Foundation, Baltimore, Maryland. This annual prize has been awarded since

1945 and is accompanied by a cash prize of \$15,000. The Badenwerk Foundation and University of Karlsruhe, Federal Republic of Germany, jointly sponsor the triennial Heinrich Hertz Preis. That prize was first awarded in 1975 and includes an honorarium of 50,000 DM (\$21,000) for scientific and technical achievements in the generation, distribution, and application of electricity. Two awards listed in part one, the Premio Nacional de Ciencias (Colombia) and the King Faisal International Prize for Science, are not discussed here. We were unable to locate the organization that awards the first of these prizes, and the King Faisal Prize was not awarded in 1983. Also, the two Lasker Awards and the three Gairdner Foundation Awards in Table 2 were each treated as single awards in part one.

The awards discussed in this essay are only a few of the many prizes that recognize scientific excellence. There has been an incredible proliferation of scientific awards. To establish a practical limit for the essay, we set an arbitrary threshold. We have only included those awards that bestow an honorarium of at least \$15,000. Although a fairly exhaustive search was conducted, we may have inadvertently omitted some awards. We intend to follow up with additional reports on less remunerative, but perhaps even more prestigious, awards. An alphabetic list of the 1982 award winners appears in Table 1.

When a prize was not awarded in 1982, we included the recipient for the nearest year. Our cutoff point for inclusion in this study was June 1983. We then corresponded with all 94 winners. This proved to be a mammoth task and explains the delay in reporting the results. Following each author's name in Table 1 is a number (or numbers) that identifies the relevant prize (or prizes). Table 2 is

alphabetized by the name of the award. It includes each recipient's most-cited paper during the period from 1961 to 1983 and the number of citations to it. Bibliographic and address information is provided for each paper. The research front for which each paper is a core document is also identified where applicable. A research front is established by identifying a group of current papers that collectively cite a cluster of earlier core papers in a specialty. Fifty-one of the award winners' papers proved to be core papers for 1981, 1982, and 1983 *Science Citation Index*[®] (*SCI*[®]) research fronts. Code numbers for seven papers that were identified in 1981 and 1982 *ISI/BIOMED*[®] research fronts, but not in *SCI* fronts, are also listed.

In assembling the data, we had initially identified papers for which the prize winners were the first authors. However, we asked all 94 winners to verify that the papers we had identified were their most relevant or significant. Of the 76 authors who replied, 58 agreed that the most-cited papers were their most important. Some authors directed us to other papers on which they were not the primary authors. Nineteen of these papers were more highly cited than those we had first identified. So we included them instead of earlier choices. We also added to the list those papers that 39 authors considered to be more important than their most-cited works. These appear after the author's most-cited paper, which is always first in Table 2. Unfortunately, 18 authors did not respond to our letters. They have been denoted by a plus (+) sign in Table 2.

The Humboldt Prize for Senior US Scientists was awarded to 58 individuals in 1982. The award, which was established in 1972 by Willy Brandt, then Chancellor of the Federal Republic of Germany, was created to honor Ameri-

Table 1: An alphabetic list of non-Nobel award winners and the award(s) they won. A=winner's name. B=award number (see Table 2).

A	B
Amelinckx, Severin	44
Anderson, Herbert L.	11
Angst, Jules	38
Arnold, Vladimir I.	7
Ashton, Norman	48
Ashwell, Gilbert	13
Atiyah, Michael F.	10
Axel, Richard	53
Becker, Erwin-Willy	20
Berry, R. Stephen	32
Bishop, J. Michael	29,39
Black, James W.	55
Blobel, Gunter	13,31
Brady, Roscoe O.	30
Braun, Armin C.	41
Brown, Michael S.	18
Burkitt, Dennis P.	2,36
Busse, Ewald W.	4
Carlsson, Arvid	13
Castor, Cecil W.	5
Changeux, Jean-Pierre	55
Chantrenne, Hubert	44
Clarke, Arthur C.	35
Cohen, Stanley	49
DeLuca, Hector F.	9
Desty, D.H.	34
Doherty, Peter C.	8
Efron, Bradley	32
El-Shazly, Khalid A.	28
Epstein, Michael A.	2
Erikson, Raymond L.	29
Felten, David L.	32
Gallo, Robert C.	29
Garwin, Richard L.	56
Ghuysen, Jean-Marie	47
Goldstein, Joseph L.	18
Hanafusa, Hidesaburo	29
Hounsfield, Godfrey N.	14
Howell, David S.	5
Hubbert, M. King	52
Hughes, John	43
Janssen, Paul A.J.	13
Johnston, Harold S.	51
Julesz, Bela	32
Kissmeyer-Nielsen, Flemming	24
Kosterlitz, Hans W.	43
Krein, Mark G.	55
Laurens, Paul	42
Lederman, Leon M.	55
Levy, Ronald G.	16
Lower, Richard R.	25
Mayer, Manfred M.	13
McCarty, Daniel J.	5
McClintock, Barbara	21,33,41
Meyer, Paul-Andre	40
Molina, Mario J.	51
Nachbin, Leopoldo	22
Nayfeh, Ali H.	28
Neddermeyer, Seth H.	11
Neufeld, Elizabeth F.	30

A	B
Nirenberg, Louis	7
Okamoto, Shunzo	12
Patz, Arnall	48
Paul, William E.	50
Perl, Martin L.	55
Peskin, Charles S.	32
Peters, Wallace	27
Pimentel, George C.	55
Polanyi, John C.	55
Potter, Michael	8
Puech, Paul	42
Robinson, Julia B.	32
Roelofs, Wendell L.	55
Rowland, F. Sherwood	51
Sandorfy, Camille	46
Sieh, Kerry E.	37
Siminovitch, Louis	15
Skipper, Howard E.	26
Snyder, Solomon H.	55
Spiegelman, Sol	10
Stevenson, George T.	16
Tonegawa, Susuma	21
Trouet, Andre	45
Umezawa, Sumio	12
Varmus, Harold E.	29,39
Verstraete, Marc	47
Weinberg, Alvin M.	17
Weissmann, Charles	19
Westheimer, Frank H.	6,54
Whitney, Hassler	55
Widdowson, Elsie M.	3
Wigler, Michael H.	1
Wrighton, Mark S.	32
Zinkernagel, Rolf M.	8

can scientists with international reputations who have promoted the interchange of ideas between German and American researchers and research institutions. For obvious reasons of space and time, we could not list or contact the 58 recipients, but we feel that this award deserves mention in this essay.

An asterisk in Table 2 indicates the 13 papers that have been discussed in *Citation Classic*[™] commentaries. The issue, year, and edition of *Current Contents*[®] in which each author's commentary appeared follows the reference, after which is given the author's institution. If a paper appeared in ISI[®]'s study of the 1,000 authors most cited from 1965 to 1978,⁸ a dagger (†) follows the author's name.

The list includes 94 authors. Eight of their publications are "kiloclassics"—

Table 2: Awards and recipients. The name of each award and the year it was given are presented as numbered, centered headers. Highly cited publications by the awardees are given after each award. Awardees' names are in bold. Citations to each paper are given in bold in parentheses after the publication information. A plus sign (+) indicates author did not respond. If the recipient was previously identified in ISI's study of the 1,000 most-cited scientists, 1965-1978, it is indicated by a dagger (†). A number symbol (#) indicates the article appeared in the study of the articles most cited from 1961 to 1982. Parts 1-5. An asterisk (*) indicates the item was the subject of a *Citation Classic*[™] commentary. The citation to the *Classic* is given after the item. If the item is a core document in an ISI research front, the number is given. The recipients' current affiliations are listed.

1. **American Business Cancer Research Foundation Award, 1982**
 + **Wigler M**, Silverstein S, Lee L-S, Pellicer A, Cheng Y & Axel R. Transfer of purified herpes virus thymidine kinase gene to cultured mouse cells. *Cell* 11:223-32, 1977. SCI 83-6764. Cold Spring Harbor Lab., NY (253)
2. **Bristol-Myers Award for Distinguished Achievement in Cancer Research, 1982**
 * **Burkitt D P**. Epidemiology of cancer of the colon and rectum. *Cancer* 28:3-13, 1971. (12/81/CP) Biomed 81-0273. Univ. London, St. Thomas's Hosp. Med. Sch., UK (446)
 * **Epstein M A**, Achong B G & Barr Y M. Virus particles in cultured lymphoblasts from Burkitt's lymphoma. *Lancet* 1:702-3, 1964. (14/79/LS) SCI 83-1209. Univ. Bristol Med. Sch., UK (625)
3. **Bristol-Myers Award for Distinguished Achievement in Nutrition Research, 1982**
McCance R A, **Widdowson E M**, Paul A A & Southgate D A T. *Composition of foods*. New York: Elsevier/North Holland Biomedical Press, 1978. 417 p. Univ. Cambridge, Addenbrooke's Hosp., UK (587)
4. **Brookdale Awards for Research in Gerontology, 1982**
Busse E W & Pfeiffer E, eds. *Behavior and adaptation in late life*. Boston, MA: Little, Brown, 1977. 382 p. SCI 83-3874 (32)
Busse E W & Blazer D G, eds. *Handbook of geriatric psychiatry*. New York: Van Nostrand Reinhold, 1980. 542 p. Duke Univ. Med. Ctr., Durham, NC (10)
5. **Ciba-Geigy ILAR Rheumatology Prize, 1982**
Castor C W & Muirden K D. Collagen formation in monolayer cultures of human fibroblasts. *Lab. Invest.* 13:560-74, 1964. (73)
Castor C W, Miller J W & Walz D A. Structural and biological characteristics of connective tissue activating peptide (CTAP-III), a major human platelet-derived growth factor. *Proc. Nat. Acad. Sci. US—Biol. Sci.* 80:765-9, 1983. Univ. Michigan Med. Sch., Ann Arbor, MI (2)
Howell D S, Pita J C, Marquez J F & Madruga J E. Partition of calcium, phosphate, and protein in the fluid phase aspirated at calcifying sites in epiphyseal cartilage. *J. Clin. Invest.* 47:1121-32, 1968. Vet. Admin. Hosp. Med. Ctr., Miami, FL (89)
McCarty D J, Kohn N N & Faires J S. The significance of calcium phosphate crystals in the synovial fluid of arthritic patients: the "pseudogout syndrome." I. Clinical aspects. *Ann. Intern. Med.* 56:711-37, 1962. SCI 83-0308 (289)
McCarty D J & Hollander J L. Identification of urate crystals in gouty synovial fluid. *Ann. Intern. Med.* 54:452-60, 1961. Med. Coll. Wisconsin, Dept. Med., Milwaukee, WI (184)
6. **Arthur C. Cope Award, 1982**
Westheimer F H. Pseudo-rotation in the hydrolysis of phosphate esters. *Account. Chem. Res.* 1:70-8, 1968. SCI 83-1156 (605)
Singh A, Thornton E R & **Westheimer F H**. The photolysis of diazo-acetylchymotrypsin. *J. Biol. Chem.* 237:PC3006-8, 1962. Harvard Univ., Dept. Chem., Cambridge, MA (108)
7. **Holger Crafoord Prizes, 1982**
Arnold V I & Avez A. *Problemes ergodiques de la mecanique classique*. (Ergodic problems of classical mechanics.) Paris: Gauthier-Villars Editeur, 1967. 243 p. SCI 81-0580. Univ. Moscow, Dept. Math., USSR (265)
Nirenberg L. Remarks on strongly elliptic partial differential equations. *Commun. Pure Appl. Math.* 8:649-75, 1955. New York Univ., Courant Inst. Math. Sci., NY (116)
8. **Paul Ehrlich-Ludwig-Darmstaedter Prize, 1983**
 * **Doherty P C**, Blanden R V & **Zinkernagel R M**. Specificity of virus-immune effector T cells for H-2K or H-2D compatible interactions: implications for H-antigen diversity. *Transplant. Rev.* 29:89-124, 1976. (18/83/LS) SCI 81-1438 (569)

- Zinkernagel R M & Doherty P C.** Restriction of *in vitro* T cell-mediated cytotoxicity in lymphocytic choriomeningitis within a syngeneic or semiallogeneic system. *Nature* 248:701-2, 1974. SCI 83-1491. Univ. Zurich, Inst. Pathol., Switzerland; Australian Natl. Univ., John Curtin Sch. Med. Res., Canberra, Australia (394)
- +**Potter M†.** Immunoglobulin-producing tumors and myeloma proteins of mice. *Physiol. Rev.* 52:631-719, 1972. NIH, NCI, Bethesda, MD (321)
9. **FASEB Award for Research in the Life Sciences, 1982**
Garabedian M, Holick M F, DeLuca H F† & Boyle I T. Control of 25-hydroxycholecalciferol metabolism by parathyroid glands. *Proc. Nat. Acad. Sci. US* 69:1673-6, 1972. SCI 83-6203 (436)
Holick M F, Schnoes H K, DeLuca H F†, Suda T & Cousins R J. Isolation and identification of 1,25-dihydroxycholecalciferol. A metabolite of vitamin D active in intestine. *Biochemistry* 10:2799-804, 1971. Univ. Wisconsin, Dept. Biochem., Madison, WI (280)
10. **Antonio Feltrinelli Prizes, 1982**
Atiyah M F & Singer I M. The index of elliptic operators. *Ann. Math.* 87:484-604, 1968. SCI 83-1324. Univ. Oxford, Math. Inst., UK (137)
#Gillespie D & Splegelman S.† A quantitative assay for DNA-RNA hybrids with DNA immobilized on a membrane. *J. Mol. Biol.* 12:829-42, 1965. (11/77) Columbia Univ., Inst. Cancer Res., New York, NY (1,755)
11. **Enrico Fermi Memorial Award, 1982**
+**Anderson H L, Bharadwaj V K, Booth N E, Fine R M, Francis W R, Gordon B A, Heisterberg R H, Hicks R G, Kirk T B W, Kirkbride G I, Loomis W A, Matis H S, Mo L W, Myrianthopoulos L C, Pipkin F M, Pordes S H, Quirk T W, Shambroom W D, Skuja A, Verhey L J, Williams W S C, Wilson R & Wright S C.** Measurement of nucleon structure function in muon scattering at 147 GeV/c. *Phys. Rev. Lett.* 37:4-7, 1976. Univ. Chicago, Dept. Phys., IL (97)
Neddermeyer S H & Anderson C D. Note on the nature of cosmic-ray particles. *Phys. Rev.* 51:884-6, 1937. Univ. Washington, Dept. Phys., Seattle, WA (18)
12. **Fujihara Prize, 1982**
Okamoto S. *Introduction to earthquake engineering.* New York: Wiley, 1973. 571 p. Saitama Univ., Urawa City, Japan (21)
Umezawa S. Structures and syntheses of aminoglycoside antibiotics. *Advan. Carbohydr. Chem. Biochem.* 30:111-82, 1974. Microbial Chem. Res. Fdn., Inst. Bioorgan. Chem., Kawasaki, Japan (109)
13. **Gairdner Foundation International Awards, 1982**
Ashwell G & Morell A G. The role of surface carbohydrates in the hepatic recognition and transport of circulating glycoproteins. *Advan. Enzymol. Relat. Areas Mol.* 41:99-128, 1974. NIH, NIAMDD, Bethesda, MD (636)
#Blobel G† & Dobberstein B. Transfer of proteins across membranes. I. Presence of proteolytically processed and unprocessed nascent immunoglobulin light chains on membrane-bound ribosomes of murine myeloma. *J. Cell Biol.* 67:835-51, 1975. SCI 83-2966 (1,080)
Blobel G†. Intracellular protein topogenesis. *Proc. Nat. Acad. Sci. US—Biol. Sci.* 77:1496-500, 1980. SCI 83-2966. Rockefeller Univ., New York, NY (167)
#Bertler A, Carlsson A† & Rosengren E. A method for the fluorimetric determination of adrenaline and noradrenaline in tissues. *Acta Physiol. Scand.* 44:273-92, 1958. (49/79/LS) SCI 83-2640 (1,108)
Carlsson A†, Lindqvist M, Magnusson T & Waldeck B. On the presence of 3-hydroxy-tyramine in brain. *Science* 127:471, 1958. Univ. Gothenburg, Dept. Pharmacol., Sweden (262)
Janssen P A J, Niemegeers C J E & Schellekens K H L. Is it possible to predict the clinical effects of neuroleptic drugs (major tranquillizers) from animal data? Part I. "Neuroleptic activity spectra" for rats. *Arzneim.-Forsch.-Drug Res.* 15:104-17, 1965. (385)
Janssen P A J, Niemegeers C J E & Schellekens K H L. Is it possible to predict the clinical effects of neuroleptic drugs (major tranquillizers) from animal data? Part II. "Neuroleptic activity spectra" for dogs. *Arzneim.-Forsch.-Drug Res.* 15:1196-206, 1965. Janssen Pharmaceut., Beerse, Belgium (103)
Kabat E A & Mayer M M. *Experimental immunochemistry.* Springfield, IL: Thomas, 1961. 905 p. SCI 83-5122 (6,207)
Mayer M M. The complement system. *Sci. Amer.* 229(5):54-66, 1973. Johns Hopkins Univ. Sch. Med., Baltimore, MD (81)

14. **Gairdner Foundation International Award of Merit, 1976**
 + Hounsfield G N. Computerized transverse axial scanning (tomography). Part I. Description of system. *Brit. J. Radiol.* 46:1016-22, 1973. SCI 83-0710. EMI Ltd., Middlesex, UK (748)
15. **Gairdner Foundation Wightman Award, 1981**
 *Rothfels K H & Slinovitch Lt. An air-drying technique for flattening chromosomes in mammalian cells grown *in vitro*. *Stain Technol.* 33:73-7, 1958. (43/84/LS) (510)
 Slinovitch L.† On the nature of hereditary variation in cultured somatic cells. *Cell* 7:1-11, 1976. SCI 83-9209. Hosp. Sick Child., Toronto, Canada (281)
16. **Armand Hammer Prize in Cancer, 1982**
 Levy R & Kaplan H S. Impaired lymphocyte function in untreated Hodgkin's disease. *N. Engl. J. Med.* 290:181-6, 1974. Biomed 82-1732 (223)
 Miller R A, Maloney D G, Warnke R & Levy R. Treatment of B-cell lymphoma with monoclonal anti-idiotype antibody. *N. Engl. J. Med.* 306:517-22, 1982. SCI 83-3616. Stanford Univ. Med. Ctr., CA (91)
 Stevenson G T & Dorrington K J. The recombination of dimers of immunoglobulin peptide chains. *Biochem. J.* 118:703-12, 1970. (102)
 Stevenson G T & Stevenson F K. Antibody to a molecularly-defined antigen confined to a tumour cell surface. *Nature* 254:714-6, 1975. Univ. Southampton, Lymphoma Res. Unit, UK (42)
17. **Harvey Prize, 1982**
 + Weinberg A M & Wigner E P. *The physical theory of neutron chain reactors*. Chicago: University of Chicago Press, 1958. 801 p. SCI 83-0471. Inst. Energy Analysis, Oak Ridge, TN (572)
18. **Lita Annenberg Hazen Award for Excellence in Clinical Research, 1982**
 Goldstein J Lt, Anderson R G W & Brown M St. Coated pits, coated vesicles, and receptor-mediated endocytosis. *Nature* 279:679-85, 1979. SCI 83-0860 (722)
 Goldstein J Lt & Brown M St. The low-density lipoprotein pathway and its relation to atherosclerosis. *Annu. Rev. Biochem.* 46:897-930, 1977. SCI 83-0776. Univ. Texas Hlth. Sci. Ctr., Dallas, TX (619)
19. **Dr. H.P. Heineken Prize, 1982**
 Schaffner W & Weissmann C. A rapid, sensitive, and specific method for the determination of protein in dilute solution. *Anal. Biochem.* 56:502-14, 1973. (601)
 Flavell R A, Sabo D L, Bandle E F & Weissmann C. Site-directed mutagenesis: generation of an extracistronic mutation in bacteriophage Q β RNA. *J. Mol. Biol.* 89:255-72, 1974. Univ. Zurich, Inst. Mol. Biol. I, Switzerland (78)
20. **Heinrich Hertz Preis, 1982**
 Becker E W, Bier K & Henkes W. Strahlen aus kondensierten Atomen und Molekeln im Hochvakuum. (Radiation of condensed atoms and molecules in a high vacuum.) *Z. Phys.* 146:333-8, 1956. (57)
 Becker E W. Separation nozzle. (Villani S, ed.) *Uranium enrichment*. New York: Springer-Verlag, 1979. p. 245-68. Nucl. Res. Ctr., Karlsruhe Inst. Nucl. Proc. Tech., FRG (2)
21. **Louisa Gross Horwitz Prize, 1982**
 + McClintock B. Chromosome organization and genic expression. *Cold Spring Harbor Symp.* 16:13-47, 1951. Cold Spring Harbor Lab., NY (322)
 + Tonegawa S, Maxam A M, Tizard R, Bernard O & Gilbert W. Sequence of a mouse germ-line gene for a variable region of an immunoglobulin light chain. *Proc. Nat. Acad. Sci. US* 75:1485-9, 1978. Biomed 82-0015. MIT, Dept. Biol., Cambridge, MA (238)
22. **Bernardo A. Houssay Science Prize, 1982**
 Nachbin L. *Topology and order*. Huntington, NY: Krieger, 1976. 122 p. Univ. Rochester, Dept. Math., NY (103)
23. **Humboldt Prize for Senior US Scientists, 1982**
 There were 58 awardees in 1982.
24. **Anders Jahres Medisinski Priser, 1982**
 *Kissmeyer-Nielsen F, Olsen S, Petersen V P & Fjeldborg O. Hyperacute rejection of kidney allografts, associated with pre-existing humoral antibodies against donor cells. *Lancet* 2:662-5, 1966. (23/81/CP) SCI 83-1704. Univ. Aarhus, Dept. Clin. Immunol., Denmark (348)

25. **Ernest-Jung-Preis für Medizin, 1983**
Lower R R, Stofer R C & Shumway N E. Homovital transplantation of the heart. *J. Thorac. Cardiovasc. Surg.* 41:196-204, 1961. Virginia Commonwealth Univ., Med. Coll. Virginia Hosp., Richmond, VA (139)
26. **Charles F. Kettering Prize, 1982**
 ***Skipper H E**, Schabel F M & Wilcox W S. Experimental evaluation of potential anticancer agents. XIII. On the criteria and kinetics associated with "curability" of experimental leukemia. *Cancer Chemother. Rep.* 35:1-111, 1964. (2/81/CP) SCI 83-1333. Southern Res. Inst., Birmingham, AL (555)
27. **King Faisal International Prize for Medicine, 1983**
Peters W. *Chemotherapy and drug resistance in malaria*. New York: Academic Press, 1970. 876 p. SCI 83-3315. London Sch. Hyg. Trop. Med., Dept. Med. Protozool., UK (157)
28. **Kuwait Foundation for the Advancement of Sciences Prize, 1981**
El-Shazly K. Degradation of protein in the rumen of sheep. 1. Some volatile fatty acids, including branched-chain isomers found *in vivo*. *Biochem. J.* 51:640-7, 1952. Univ. Alexandria, Fac. Agricult., Egypt (115)
Nayfeh A H. *Perturbation methods*. New York: Wiley, 1973. 425 p. SCI 83-8712. Yarmouk Univ., Fac. Eng., Irbid, Jordan (431)
29. **Albert Lasker Basic Medical Research Award, 1982**
 + Collett M S & **Erikson R L**. Protein kinase activity associated with the avian sarcoma virus *src* gene product. *Proc. Nat. Acad. Sci. US* 75:2021-4, 1978. SCI 83-0069. Harvard Univ., Dept. Cell Develop. Biol., Cambridge, MA (509)
 Morgan D A, Ruscetti F M & **Gallo R C**†. Selective *in vitro* growth of T lymphocytes from normal human bone marrows. *Science* 193:1007-8, 1976. SCI 83-2933 (452)
 Poiesz B J, Ruscetti F W, Gazdar A F, Bunn P A, Minna J D & **Gallo R C**†. Detection and isolation of type C retrovirus particles from fresh and cultured lymphocytes of a patient with cutaneous T-cell lymphoma. *Proc. Nat. Acad. Sci. US—Biol. Sci.* 77:7415-9, 1980. SCI 83-2933. NIH, NCI, Bethesda, MD (210)
Hanafusa H, Hanafusa T & Rubin H. The defectiveness of Rous sarcoma virus. *Proc. Nat. Acad. Sci. US* 49:572-80, 1963. (252)
Hanafusa H, Halpern C C, Buchhagen D L & Kawai S. Recovery of avian sarcoma virus from tumors induced by transformation-defective mutants. *J. Exp. Med.* 146:1735-47, 1977. Biomed 82-0027. Rockefeller Univ., New York, NY (112)
 Stehelin D, **Varmus H E**, **Bishop J M**† & Vogt P K. DNA related to the transforming gene(s) of avian sarcoma viruses is present in normal avian DNA. *Nature* 260:170-3, 1976. SCI 83-0069. Univ. California Med. Sch., San Francisco, CA (336)
30. **Albert Lasker Clinical Medical Research Award, 1982**
Brady R O†, Kanfer J N & Shapiro D. Metabolism of glucocerebrosides. II. Evidence of an enzymatic deficiency in Gaucher's disease. *Biochem. Biophys. Res. Commun.* 18:221-5, 1965. SCI 83-3331 (231)
Brady R O†, Kanfer J N, Bradley R M & Shapiro D. Demonstration of a deficiency of glucocerebrosidase-cleaving enzyme in Gaucher's disease. *J. Clin. Invest.* 45:1112-5, 1966. NIH, NINCDS, Bethesda, MD (146)
 Hickman S & **Neufeld E F**. A hypothesis for I-cell disease: defective hydrolases that do not enter lysosomes. *Biochem. Biophys. Res. Commun.* 49:992-9, 1972. SCI 83-0860 (315)
 Fratantoni J C, Hall C W & **Neufeld E F**. The defect in Hurler's and Hunter's syndromes: faulty degradation of mucopolysaccharide. *Proc. Nat. Acad. Sci. US* 60:699-706, 1968. NIH, NIADDK, Bethesda, MD (276)
31. **Richard Lounsberry Prize, 1983**
Blobel G. See #13.
32. **MacArthur Prize Fellow Awards, 1982**
 + **Berry R S**. Correlation of rates of intramolecular tunneling processes, with application to some group V compounds. *J. Chem. Phys.* 32:933-8, 1960. (8/81/ET&AS,PC&ES) SCI 83-2624. Univ. Chicago, Dept. Chem., IL (547)
Efron B & Morris C. Stein's estimation rule and its competitors—an empirical Bayes approach. *J. Amer. Statist. Assn.* 68:117-30, 1973. SCI 83-2497 (63)

- Efron B.** *The jackknife, the bootstrap and other resampling plans.* Philadelphia, PA: SIAM, 1982. 92 p. Stanford Univ., Dept. Stat., Palo Alto, CA (3)
- Felten D L, Laties A M & Carpenter M B.** Monoamine-containing cell bodies in the squirrel monkey brain. *Amer. J. Anat.* 139:153-66, 1974. Biomed 82-1514 (82)
- Felten D L & Sladek J R.** Monoamine distribution in primate brain. V. Monoaminergic nuclei: anatomy, pathways and local organization. *Brain Res. Bull.* 10:171-284, 1983. Univ. Rochester Med. Ctr., NY (0)
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publications that have received more than 1,000 citations. The most-cited of these is a book entitled *Experimental Immunochemistry*. It was cited over 6,200 times between 1961 and 1983. The late Manfred M. Mayer, Johns Hopkins University School of Medicine, Baltimore, Maryland, honored by a Gairdner Foundation International Award for his work on the complement system, wrote this book with E.A. Kabat, Columbia University. The second edition of this book includes a chapter by Mayer on the complement system, a group of proteins that act in concert with antibodies to protect the body from foreign antigens. Mayer asked that we add his *Scientific American* paper to Table 2 because its reprint distribution exceeds 40,000.

The oldest publication in Table 2 is a 1935 paper by Hassler Whitney, Princeton, New Jersey. Whitney won the Wolf Prize in mathematics for his work in algebraic and differential topology.

In many of the citation studies that ISI publishes, we single out Nobel Prize winners to illustrate that citation frequency often correlates with peer estimates of scientific accomplishment. A paper becomes highly cited because many members of the scientific community have found it valuable. This is not to say that all significant research is highly cited. Some Nobelists do not appear on most-cited lists. And a number of the papers mentioned in this essay received relatively few citations.

In some cases, prize winners' most significant publications may have been so quickly absorbed into the common wisdom of the field that the explicit citation of these works was obliterated. Such cases are rare. Another reason for low citation frequency may be publication in a language not read by most scientists. Shunzo Okamoto, Saitama University, Japan, awarded the 1982 Fujihara Prize, is well-known to earthquake engineers

in both the US and Japan. According to Joseph Penzien, professor of structural engineering, University of California, Berkeley, Okamoto has published primarily in Japanese journals,⁹ which may have limited his citation frequency outside his own country.

Papers reporting work in relatively small fields may receive few citations when compared to those in larger fields. In our studies of disciplinary citation rates, we found that geoscientists¹⁰ tend to receive fewer citations than do neuroscientists.¹¹ Consequently, someone like Kerry E. Sieh, California Institute of Technology, Pasadena, who won the National Academy of Sciences Award for Initiatives in Research for contributions to earthquake engineering, would be expected to receive fewer citations than someone working on opiate receptor research, a field that has attracted many scientists.

Several of the papers in Table 2 received few citations simply because they were published quite recently. These papers were identified when we contacted the prize winners in this study. Some of these authors requested that we include these more recent but less-cited works because they consider them to be more significant.

As mentioned above, prize winning work may not be highly cited because it is "obliterated"—so integrated into a field's common wisdom that scientists neglect to cite it explicitly. For this reason, I was surprised to learn that Arthur C. Clarke's 1945 *Wireless World* article on extraterrestrial relays had been explicitly cited at all. Clarke received the Guglielmo Marconi International Fellowship. He is widely known for his contributions to the invention of the communications satellite, but he is even better known as a master of science fiction.

There isn't always a simple explanation for the paucity of citations to the

work of some authors. For a variety of reasons, good research is sometimes unappreciated or ignored by the scientific community. It may achieve delayed recognition.¹² And there may even be cases of systematic citation amnesia,¹³ although these are hard to document. However, one must also add the simple explanation that award groups are human and selections may be made for reasons other than purely scientific impact. Many choices, such as earlier Nobel Prizes, are controversial to say the least.

Several awards in Table 2 and their associated core papers have been selected from the same basic research front, for example, oncogenes and the cancer-virus connection. Several papers by winners of the 1982 Lasker Basic Medical Research Award helped identify these fronts. Two papers by Robert C. Gallo, National Cancer Institute, Bethesda, Maryland, are core to *SCI* front #83-2933, "Human T-cell lymphoma virus and adult T-cell leukemia: nucleic acid analysis and expression of virus induced by interleukin 2." Gallo won the Lasker for his discovery of the human T-cell leukemia virus, the first retrovirus known to be associated with a human malignancy.

Three of the five Lasker Basic Medical Research Award winners are represented in *SCI* front #83-0069, "Effects of epidermal, platelet-derived, and other growth factors on tyrosine and protein phosphorylation by protein kinase." J. Michael Bishop and Harold E. Varmus, University of California, San Francisco, and Raymond L. Erikson, Harvard University, Cambridge, Massachusetts, shared the Lasker with Gallo for discovering links between viruses and cancer.¹⁴

Papers by Lasker Clinical Medical Research awardee Elizabeth F. Neufeld, National Institute of Arthritis, Diabe-

tes, Digestive and Kidney Diseases (NIADDDK), Bethesda, and Prix Franqui winner André Trouet, International Institute of Cellular and Molecular Pathology, Brussels, are core in *SCI* front #83-0860, "Receptor-mediated endocytosis and role of coated vesicles in plasma membrane recycling." Prix de la Fondation Professeur Lucien Dautrebande winners John Hughes, Parke-Davis Research Unit, Cambridge, England, and Hans W. Kosterlitz, University of Aberdeen, Scotland, and Solomon H. Snyder, Johns Hopkins University, who won the Wolf Prize in medicine, are classic authors in *SCI* front #83-7424, "Synthesis and properties of beta-endorphins, opioid peptides, enkephalins, and their receptors."

Contributions by Günter Blobel, Rockefeller University, New York, to research on intracellular protein transport are reflected by his two core papers for research front #83-2966, "Membrane biogenesis and mechanism of protein insertion and secretion: use of cDNA probes in protein processing." Blobel received both the Richard Lounsberry Prize and the Gairdner Foundation International Award.

It may not be a surprise that many of the award recipients in Table 2 have won other prestigious awards. For example, Godfrey N. Hounsfield, EMI Ltd., Middlesex, UK, a 1979 Nobelist,¹⁵ had already received the 1976 Gairdner Foundation International Award of Merit for development of the computed axial tomography (CAT) scan. Barbara McClintock, Cold Spring Harbor Laboratory, New York, a 1983 Nobelist, not only received the Louisa Gross Horwitz Prize and the Prix Charles Léopold-Mayer in 1982 but also, in 1981, she won the Lasker Basic Medical Research Award and was named the first MacArthur Prize Fellow Laureate. McClintock

is credited with having contributed substantially to our understanding of the "mobility" of genes on chromosomes, so-called "jumping genes." In a subsequent report, I'll have more to say about the mythologies concerning the delayed recognition of her work.

Five of the authors in this list won two awards. As mentioned earlier, Bishop and Varmus won both the Albert Lasker Basic Medical Research Award and the 1983 Passano Award. They were recognized for demonstrating that certain cancer-causing genes from viruses are almost identical to some genes normally found in animals and for thus discovering what are now called oncogenes. Blobel, also mentioned earlier, won both the Gairdner Foundation International Award and the Lounsberry Prize.

Both the Bristol-Myers Award for Distinguished Achievement in Cancer Research and the Charles S. Mott Prize went to Dennis P. Burkitt, St. Thomas's Hospital Medical School, London. Burkitt discovered the role played by a virus in the development of a form of cancer that bears his name, Burkitt's lymphoma. He shared the Bristol-Myers award with Michael A. Epstein, University of Bristol Medical School, who isolated the previously unidentified Epstein-Barr virus from Burkitt's lymphoma. Frank H. Westheimer, Harvard University, received both the Robert A. Welch Award in Chemistry and the Arthur C. Cope Award. Westheimer, a pioneer bio-organic chemist, is probably best known for his contributions to photo-affinity labeling, a method for identifying in membranes those compounds that bind to specific hormones or drugs.

A number of award recipients are past winners of other prizes listed in Table 2. Burkitt won the Gairdner Foundation International Award in 1973 and the Ehrlich Award in 1972. In 1965, Daniel

J. McCarty, Medical College of Wisconsin, Milwaukee, also received the Gairdner Foundation International Award. In 1982, he won the Ciba-Geigy ILAR Prize for rheumatology research. Howard E. Skipper, Southern Research Institute, Birmingham, Alabama, who received the 1982 Charles F. Kettering Prize for his research on the treatment of disseminated cancers and Arnall Patz, Johns Hopkins University, who received the 1981 RPB-Jules Stein Award, are previous Lasker awardees. Patz was the first person to discover that oxygen was responsible for retrolental fibroplasia, a disorder that is responsible for blindness in premature infants. Hounsfeld won the Lasker Clinical Medical Research Award in 1975.

Hughes and Kosterlitz, won the 1982 Dautrebande Prize for their work on opiate receptors—sites in the brain that bind opiates with a high affinity. Snyder, as I mentioned, was named a Wolf Prize recipient for the development of ways for labeling neurotransmitter receptors. Hughes, Kosterlitz, and Snyder were Lasker Basic Medical Research Award winners in 1978. Kosterlitz and Snyder also received Harvey Prizes in 1981 and 1978, respectively.

Of the 94 scientists identified in this essay, 16 were included in our study of the 1,000 authors most cited from 1965 to 1978.⁸ Three of the Gairdner Foundation Award winners are in the 1,000 most-cited author list. Blobel won the award for his work on intracellular protein transport. Arvid Carlsson, University of Gothenburg, Sweden, won it for research on the role of amines, particularly dopamine, as neurotransmitters. Louis Siminovitch, Hospital for Sick Children, Toronto, Canada, received the Gairdner Foundation Wightman Award in 1981 for his many contributions to genetics research. The Wightman Award is given

from time to time to a Canadian who has demonstrated leadership in medicine and medical science.

Four of the Wolf Prize winners were on the list of 1,000 most-cited authors: Snyder, mentioned earlier; Martin L. Perl, Stanford Linear Accelerator Center, California, who won the Wolf Prize in physics; John C. Polanyi, University of Toronto, who won the chemistry prize; and Jean-Pierre Changeux, Institut Pasteur, Paris, who won the prize in medicine. Michael S. Brown and Joseph L. Goldstein, University of Texas Health Science Center, Dallas, received the Lita Annenberg Hazen Award for Excellence in Clinical Research for identifying low-density lipoprotein receptor pathways. Three Lasker Award winners were also on the 1,000 most-cited authors list: Gallo, Bishop, and Roscoe O. Brady, National Institute of Neurological and Communicative Disorders and Stroke (NINCDS), Bethesda. Brady shared the Lasker Clinical Medical Research Award with Neufeld for their work on lipid storage diseases and mucopolysaccharide storage diseases, both childhood disorders.

Other scientists who appeared on our list of 1,000 most-cited authors include Hector F. DeLuca, University of Wisconsin, Madison, who won the Federation of American Societies for Experimental Biology (FASEB) Award; William E. Paul, National Institute of Allergy and Infectious Diseases (NIAID), Bethesda, who won the Texas Instruments Foundation Founders' Prize; Michael Potter, National Cancer Institute (NCI), Bethesda, who won the Paul Ehrlich-Ludwig-Darmstaedter Prize; and Sol Spiegelman, Columbia University, who won the Antonio Feltrinelli Prize.

It is significant that six of the award-winning papers were included in our recent study of 500 *Citation Classics*.¹⁶ I

would expect that most of these papers would become *Citation Classics*. Blobel and Carlsson, winners of the Gairdner Foundation International Award, are mentioned in that study. So are two Wolf Prize recipients—Changeux and James W. Black. Black, Wellcome Research Laboratory, Beckenham, England, received the prize for developing agents that block beta-adrenergic and histamine receptors. Others identified in that study are Feltrinelli winner Spiegelman and Dautrebande winners Hughes and Kosterlitz.

Although the awards that are discussed in this essay may not receive the same public acclaim as a Nobel Prize, they serve many important and useful functions. The first is to recognize that outstanding work is done by many scientists today. Scientific research can be lonely and frustrating at times, and researchers, no less than Hollywood celebrities, deserve and enjoy recognition from their peers. A second and equally important function concerns interdisciplinary scientific communication. While the papers in Table 2 have generally had widespread impact, as evidenced by the citations they've acquired, most of this influence is or was originally limited to each prize winner's field. By recognizing ideas and discoveries that at first seemed very specialized, awarding committees heighten the visibility and, therefore, the potential applicability of the prize winning work.

Our purpose in this essay has been (a) to identify the many prestigious non-Nobel awards; (b) to name recent recipients of these awards; (c) to identify their most-cited and most-significant papers; and (d) to point out the multiplicity of awards given to the same persons.

Considering that many important scientists never receive any of the prestigious awards we've named, can we dare

to suggest that one Nobel Prize ought to be enough for a lifetime? If one assumes that awards are meant to spur the recipients on to even greater heights, then we are caught in a vicious trap. Scientists must either be allowed and encouraged to receive both second Nobels and other prizes or we must create a Super Nobel Prize. I suppose that some of the more recent prizes were created with this need in mind. Science awards benefit both those who receive them and the members of their invisible colleges as well. These prizes provide public recognition

of past research frontiers that have become today's accepted wisdom.

Since it is almost two years since we began this study,¹ many readers may not have convenient access to part one. Reprints are available upon request.

* * * * *

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