

# Measuring and Assessing Science

**Academic Science** (Uncertain utility)

**Applied Science** (Clear goals and targets)

**“Success in the laboratory does not always translate into success in the market place”**

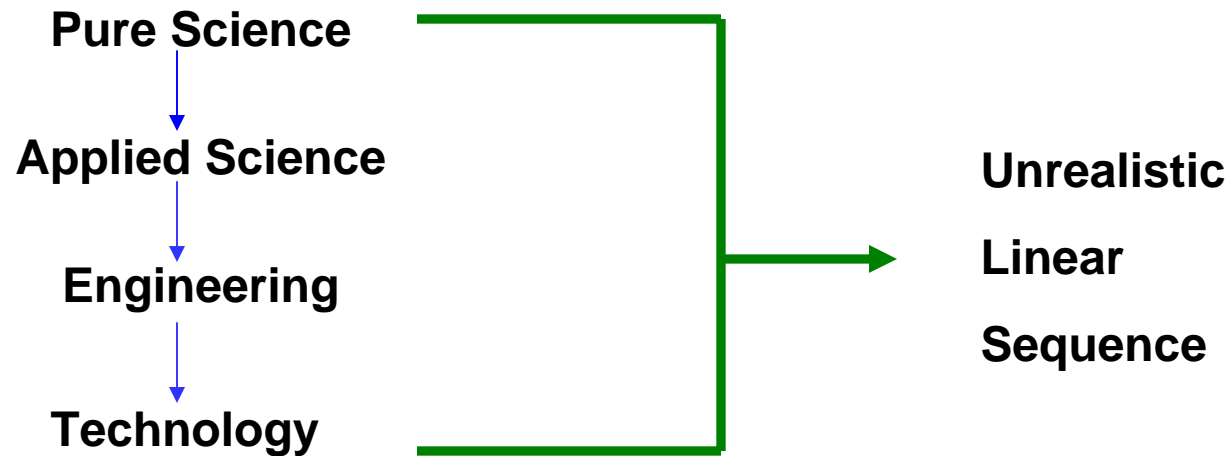
Science by itself provides no panacea for individual, social and economic ills. It can be effective in national welfare only as a member of a team. But without scientific progress, no amount of achievement in other directions can insure our health, prosperity and security.

**Vannevar Bush**

**"Endless Horizons -1946"**

**Science** – "A way of understanding the world"

**Technology** – "A way of controlling the world"



## History of support for science

**Francis Bacon** – “**New Atlantis**” – 1624 .....

“A utopian society that supported systematic scientific research to unlock the secrets of nature and systematic application of this knowledge to produce practical benefits”.

**-Led to formation of the Royal Society**

“ Low Budget “ Science till **World War II**

# Assessing Scientific Activity

1. Personal Judgments (Informed or prejudiced)
2. Impersonal Quantitation (“Scientometrics”)

## Scientometrics

“ The study of the measurement of scientific and technological progress”

“Citation Indexes for science: A new dimension in documentation through association of ideas” - E.Garfield *Science* 122, 108-111 (1955)

Science Citation Index



Web of Science

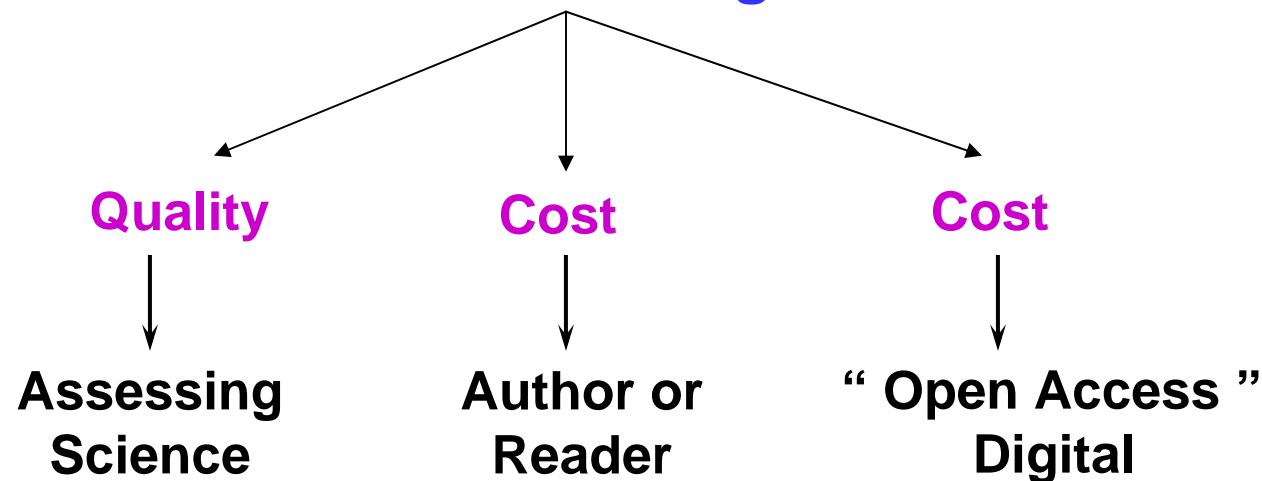
# Science, Scientists and Scientometrics

**Man is an Animal that writes Letters**

– Charles Dodgson (Lewis Carroll)

**Scientists are animals who like to publish papers**

## Science Publishing Journals



# HISTORY



Current Contents



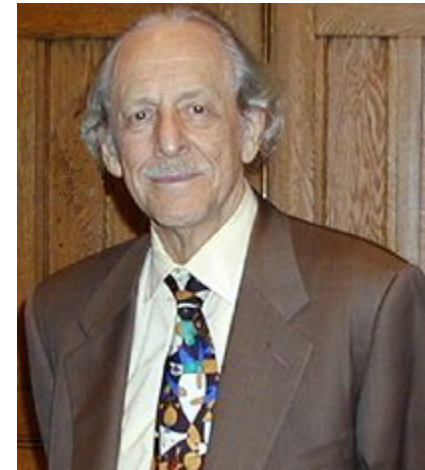
Science Citation Index



Print /CD /on-line

Web of Science

(Links to the literature)



Eugene Garfield

**Citation Indexes for Science: A New Dimension in Documentation through Association of Ideas**

Garfield, E., *Science*, 1955, 122, 108-111

**“The new bibliographic tool, like others that already exist, is just a starting point in literature research. It will help in many ways, but one should not expect it to solve all our problems”**

CONTINUED

CHEM SENSES 30(5)05

- Olfactory receptor neurons in two heliothine moth species responding selectively to aliphatic green leaf volatiles, aromatic compounds, monoterpenes and sesquiterpenes of plant origin. T. Rostein, M. Strandén, A.K. Borg-Karlson, H. Mustaparta .....443

938NE

INTERCIENCIA

INTERCIENCIA

MULTILINGUAL JOURNAL-EACH ABSTRACT IN ENGLISH, SPANISH AND PORTUGUESE

VOL.30 NO.6 JUNE 2005

## ARTICLES

- Origin and expansion of windmills in Spain. (in Spanish) J.I. Rojas-Sola, J.M. Amezcua-Ogayar .....316
- Toxicological evaluation of soils contaminated with new and weathered oil by tests with leguminous plants. (in Spanish) M.D. Rivera-Cruz, A. Trujillo-Narcia, M.A.M. de la Cruz, E.M. Chavez .....326
- Characterization of La<sub>1-x</sub>Sr<sub>x</sub>NiO<sub>3</sub> and La<sub>2-2x</sub>Sr<sub>2x</sub>NiO<sub>4-δ</sub> perovskites obtained through the autocombustion method. (in Spanish) G. Valderrama, M.R. de Goldwasser, M.J. Perez-Zurita, M.L. Cubeiro, C.U. de Navarro .....332
- Technical and graphical comparison of windmills in Spain. (in Spanish) J.I. Rojas-Sola, J.M. Amezcua-Ogayar .....339
- A tentative land evaluation for water retention in two microbasins of the Santo Domingo River Basin, Merida, Venezuela. S. Rivas, J. Oballos, G. Ochoa, J. Santiago .....347
- Contribution of the syncytial respiratory virus and bacteria with the presence of asthma in an adult population. (in Spanish) N. Valero, J. Estevez, F. Arocha, E. Rincon, F. Anez, L.M. Espina, E. Melean, Y. Larreal, M. Maldonado, J. Arias, et al .....356
- A soil test for determining available copper in acidic soils of Venezuela. B. Rodriguez, R. Ramirez .....361
- Formulation of mixtures of mediant substrates - Lineal programming. (in Spanish) B.P.Z. Morales, P.S. Garcia, V.H.V. Haller, D.E. Victoria, A.G. Spinola .....365
- Science, religion and economic development. K. Jaffe .....370
- 2075 AD. S.S. Tillet .....375

## EDITORIALS

- Technological dismantling in Venezuela - II. J. Requena .....314

942QJ

NATURE

NATURE PUBLISHING GROUP

ARTICLES AND ABSTRACTS IN ENGLISH

VOL.436 NO.7047 JULY 7 2005

## ARTICLES

- Assessment of Mars Exploration Rover landing site predictions. M.P. Golombek, R.E. Arvidson, J.F. Bell, P.R. Christensen, J.A. Crisp, L.S. Crumpler, B.L. Ehlmann, R.L. Ferguson, J.A. Grant, R. Greeley, et al .....44
- An integrated view of the chemistry and mineralogy of martian soils. A.S. Yen, R. Gellert, C. Schroder, R.V. Morris, J.F. Bell, A.T. Knudson, B.C. Clark, D.W. Ming, J.A. Crisp, R.E. Arvidson, et al .....49
- Solar eclipses of Phobos and Deimos observed from the surface of Mars. J.F. Bell, M.T. Lemmon, T.C. Duxbury, M.Y.H. Hubbard, M.J. Wolff, S.W. Squyres, L. Craig, J.M. Ludwinski .....55
- Aeolian processes at the Mars Exploration Rover Meridiani Planum landing site. R. Sullivan, D. Banfield, J.F. Bell, W. Calvin, D. Fike, M. Golombek, R. Greeley, J. Grotzinger, K. Herkenhoff, D. Jerolmack, et al .....58
- Indication of drier periods on Mars from the chemistry and mineralogy of atmospheric dust. W. Goetz, P. Bertelsen, C.S. Binau, H.P. Gunnlaugsson, S.F. Hviid, K.M. Kinch, D.E. Madsen, M.B. Madsen, M. Olsen, R. Gellert, et al .....62
- Water alteration of rocks and soils on Mars at the Spirit rover site in Gusev crater. L.A. Haskin, A. Wang, B.L. Jolliff, H.Y. McSween, B.C. Clark, D.J. Des Marais, S.M. McLennan, N.J. Tosca, J.A. Hurowitz, J.D. Farmer, et al .....66

CONTINUED

CONTINUED

NATURE 436(7047)05

- Dynamic predictive coding by the retina. T. Hasaya, S.A. Baccus, M. Meister .....71
- Genome-wide analysis of human kinases in clathrin- and caveolae/raft-mediated endocytosis. L. Pelkmans, E. Fava, H. Grabner, M. Hannus, B. Habermann, E. Kraus, M. Zerial .....78
- Photon blockade in an optical cavity with one trapped atom. K.M. Birnbaum, A. Boca, R. Miller, A.D. Boozer, T.E. Northup, H.J. Kimble .....87
- Doping semiconductor nanocrystals. S.C. Erwin, L.J. Zu, M.I. Haftel, A.L. Efros, T.A. Kennedy, D.J. Norris .....91
- Breaking of Henry's law for noble gas and CO<sub>2</sub> solubility in silicate melt under pressure. P. Sarda, B. Guillot .....95
- Generation time and temporal scaling of bird population dynamics. B.E. Saether, R. Lande, S. Engen, H. Weimerskirch, M. Lillegard, R. Altwegg, P.H. Becker, T. Bregnballe, J.E. Brommer, R.H. McCleery, et al .....99
- Nicotine reinforcement and cognition restored by targeted expression of nicotinic receptors. U. Maskos, B.E. Molles, S. Pons, M. Besson, B.P. Guiard, J.P. Guilloux, A. Evrard, P. Cazala, A. Cormier, M. Mamel-Engvall, et al .....103
- ATP is a mediator of chemosensory transduction in the central nervous system. A.V. Gourine, E. Llaudet, N. Dale, K.M. Spyer .....108
- Angiotensin-converting enzyme 2 protects from severe acute lung. Y. Imai, K. Kuba, S. Rao, Y. Huan, F. Guo, B. Guan, P. Yang, R. Sarao, T. Wada, H. Leong-Poi, et al .....112
- Integrative genomic analyses identify MITF as a lineage survival oncogene amplified in malignant melanoma. L.A. Garraway, H.R. Widlund, M.A. Rubin, G. Getz, A.J. Berger, S. Ramaswamy, R. Beroukhim, D.A. Milner, S.R. Granter, J.Y. Du, et al .....117
- Rac1b and reactive oxygen species mediate MMP-3-induced EMT and genomic instability. D.C. Radisky, D.D. Levy, L.E. Littlepage, H. Liu, C.M. Nelson, J.E. Fata, D. Leake, E.L. Godden, D.G. Albertson, M.A. Nieto, et al .....123
- Kinase-regulated quantal assemblies and kiss-and-run recycling of caveolae. L. Pelkmans, M. Zerial .....128
- Molecular basis of photoprotection and control of photosynthetic light-harvesting. A.A. Pascal, Z.F. Liu, K. Broess, B. van Oort, H. van Amerongen, C. Wang, P. Horton, B. Robert, W.R. Chang, A. Ruban .....134
- X-ray structure of a tetranucleosome and its implications for the chromatin fibre. T. Schalkh, S. Duda, D.F. Sargent, T.J. Richmond .....138

## BOOK REVIEWS

- Hitlers bombs: The secret history of the German nuclear weapons trials (German), by R. Karlisch (2005). D. Hoffmann .....25
- Happiness: Lessons from a new science, by R. Layard (2005). D. Evans .....26
- Making happy people: The nature of happiness and its origins in childhood, by P. Martin (2005). D. Evans .....26
- Happiness: The science behind your smile, by D. Nettle (2005). D. Evans .....26

## CORRECTIONS

- Granular matter: A tail of tails (vol 435, pg 1041, 2005). M. van Hecke .....37

## EDITORIALS

- Climate of distrust .....1
- Rules of engagement .....2
- Playing the name game .....2
- Climate change: is the US Congress bullying experts? Q. Schiermeier, J. Barton .....7
- Computer hardware: Silicon down to the wire. C. Macilwain .....22
- The mental Universe. R.C. Henry .....29
- Neuroscience - A home for the nicotine habit. J.A. Kauer .....31
- Solid-state physics - Doping the undopable. G. Galli .....32
- Cancer biology - The weakest link? M. Glenn .....33
- Conservation biology - Where slugs may safely graze. P.D. Moore .....35
- Nonlinear dynamics - When instability makes sense. P. Ashwin, M. Timme .....36
- Acoustics: The vocal tract and the sound of a didgeridoo. A. Tarnopolsky, N. Fletcher, L. Hollenberg, B. Lange, J. Smith, J. Wolfe .....39

CONTINUED

July 25, 2005

Volume 36

Number 30

# CURRENT CONTENTS®

## Agriculture, Biology & Environmental Sciences

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Agronomy • Animal Science • Applied Microbiology • Biodiversity & Natural Resource Conservation • Biotechnology • Crop & Soil Sciences  
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Web Sites 1 to 10 of 13

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<http://www.chemweb.com> The ChemWeb.com web site provides an authoritative source of chemical information and resources for the worldwide chemistry community. Some of the features of the site include a library of chemical formulas, reaction schemes, molecular models, and a comprehensive database of chemical literature. The site also includes links to the Chemistry Department's top-level pages. The journal articles are available in full text.

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<http://www.chemweb.com> The ChemWeb Chemistry Resources website provides links to numerous chemistry-related sites, including academic institutions, research organizations, news sites, government agencies, and educational institutions. The site is frequently updated and contains a wealth of information on chemistry and related fields. [full record](#) ISI Review Date: 24-OCT-2002

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<http://www.chemdex.org/> Chemdex is a comprehensive chemistry directory containing more than 7100 international links. Information is organized into thirteen major categories: named societies; government; companies; chemistry; compounds and molecular communication; standards; the periodic table; the elements; and miscellaneous links. Twenty-three subjects, from analytical to theoretical chemistry, appear under the chemistry category heading. The site also includes pages featuring the most popular, newest, and top-rated links, as well as a page of editor picks. [full record](#) ISI Review Date: 15-OCT-2002

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## On Libraries



“The faint aroma of gum and calico that hangs about a library is as the fragrance of incense to me. I think the most beautiful sight is the gilt edged backs of a row of books on a shelf”

- R.K. Narayan  
The Hindu 23 Sep 1951



**Table 1: Citation frequency distribution for papers in the *SCI*<sup>®</sup>, 1945-1988. A=number of citations. B=number of items receiving that number of citations. C=percent of entire *SCI* file.**

A	B	C
> 10,000	20	*
5,000-9,999	47	*
4,000-4,999	23	*
3,000-3,999	54	*
2,000-2,999	181	*
1,000-1,999	1,051	*
900-999	325	*
800-899	438	*
700-799	727	*
600-699	1,073	*
500-599	1,828	*
400-499	3,406	0.01
300-399	7,736	0.02
200-299	21,952	0.07
100-199	112,299	0.34
50-99	348,537	1.06
25-49	842,950	2.58
15-24	1,089,731	3.33
10-14	1,207,577	3.69
5-9	2,955,984	9.03
2-4	7,877,213	24.07
1	18,255,577	55.78
<b>TOTAL</b>	<b>32,728,729</b>	<b>100.00</b>

\*=less than 0.01 percent of the *SCI* file, 1945-1988.

**1945 - 1988**

**Total 175 million items  
Cited : 33 million**

**Only 18 % of all published  
material is cited at least  
once**

**0 Citations : 82.00 %  
<10 Citations : 16.02 %**

**Only 2 % of all published  
work is cited at least  
10 times**

**Current Contents<sup>®</sup>**

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## **Bradford's Law 1934, 1950 (Paraphrased by Garfield, 1971)**

**(Law of Diminishing Returns)**

**“.....No matter what the specialty, a relatively small core of journals will account for as much as 90 % of the significant literature, while attempts to gather 100 % of it will add journals to the core at an exponential rate.”**

**Indexing services that ignore Bradford's law  
“in attempting to realize the myth of complete coverage” do so at the risk of great financial peril”**

**~ 20 % authors contribute to over 80 % of the literature**

**Authors ----- Institutions----- Countries**

# Pattern of Scientific Productivity

## LOTKA'S LAW (AN INVERSE SQUARE LAW)

A. J. Lotka *1926 J. Wash. Acad. Sci 16, 317*

“The number of authors publishing ‘n’ papers is  $1/n^2$  of those publishing 1 paper”

**General relation  $1/n^c$  with  $c \rightarrow 2$**

“Statistical regularities can be observed in many natural and social phenomena”

# ZIPF'S LAW

“Frequency of the  $k$  th most common word in a text is roughly proportional to  $1/k$ .”

G. K. Zipf “Human behavior and principle of least effort”

# Protein Estimation

Rank : 1  
Citations : 275,669  
Lowry *et al.*  
*JBC*, 1951

PROTEIN MEASUREMENT WITH  
THE FOLIN PHENOL REAGENT

Rank : 3  
Citations : 107,583  
Bradford M. M.  
*Anal. Biochem*, 1976

RAPID AND SENSITIVE METHOD FOR  
QUANTITATION OF MICROGRAM  
QUANTITIES OF PROTEIN UTILIZING  
PRINCIPLE OF PROTEIN-DYE BINDING

## Protein Estimation

Rank : 1

Citations : 275,669

Lowry *et al.*

*JBC*, 1951

### PROTEIN MEASUREMENT WITH THE FOLIN PHENOL REAGENT\*

By OLIVER H. LOWRY, NIRA J. ROSEBROUGH, A. LEWIS FARR,  
AND ROSE J. RANDALL

(From the Department of Pharmacology, Washington University  
School of Medicine, St. Louis, Missouri)

(Received for publication, May 28, 1951)

Since 1922 when Wu proposed the use of the Folin phenol reagent for the measurement of proteins (1), a number of modified analytical procedures utilizing this reagent have been reported for the determination of proteins in serum (2-6), in antigen-antibody precipitates (7-9), and in insulin (10).

Although the reagent would seem to be recommended by its great sensitivity and the simplicity of procedure possible with its use, it has not found great favor for general biochemical purposes.

In the belief that this reagent, nevertheless, has considerable merit for certain application, but that its peculiarities and limitations need to be understood for its fullest exploitation, it has been studied with regard to effects of variations in pH, time of reaction, and concentration of reactants, permissible levels of reagents commonly used in handling proteins, and interfering substances. Procedures are described for measuring protein in solution or after precipitation with acids or other agents, and for the determination of as little as 0.2  $\gamma$  of protein.

#### Method

*Reagents*—Reagent A, 2 per cent  $\text{Na}_2\text{CO}_3$  in 0.10 N NaOH. Reagent B, 0.5 per cent  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  in 1 per cent sodium or potassium tartrate. Reagent C, alkaline copper solution. Mix 50 ml. of Reagent A with 1 ml. of Reagent B. Discard after 1 day. Reagent D, carbonate-copper solution, is the same as Reagent C except for omission of NaOH. Reagent E, diluted Folin reagent. Titrate Folin-Ciocalteu phenol reagent ((11), Eimer and Amend, Fisher Scientific Company, New York) with NaOH to a phenolphthalein end-point. On the basis of this titration dilute the Folin reagent (about 2-fold) to make it 1 N in acid. Working standards may be prepared from human serum diluted 100- to 1000-fold (approximately 700 to 70  $\gamma$  per ml.). These in turn may be checked against a standard solution of crystalline bovine albumin (Armour and

\* Supported in part by a grant from the American Cancer Society on the recommendation of the Committee on Growth of the National Research Council.

# Phosphate Estimation

**Rank : 23**

**Citations : 20,120**

**Fiske, SubbaRow**

***JBC, 1925***



**The colorimetric determination of phosphorus**



# Yellapragada SubbaRow (1895-1948)

Bhimavaram, Harvard, Lederle Laboratories

Phosphorus estimation; **Fiske-Subbarow** reagent

Discovery of Phosphocreatine and **ATP**

Discovery of **folic acid**

Pernicious anaemia factor- towards **Vitamin B-12**

**Anti-folates** to limit cell proliferation- cancer chemotherapy

Discovery of tetracyclines- **aureomycin**

**Hetrazan**- for filariasis

"Few laymen knew directly of **Dr. SubbaRow's** work- his contributions to the control of certain types of anaemia, his researches in nutrition and his investigations of drugs- but many advances in modern medicine stand as monument to his genius and countless thousands will benefit for years to come from investigations he set in motion and supervised"

*New York Herald Tribune  
August 12, 1948*

# An Anomaly

Rank : 18

Citations : 22,035

Scatchard G

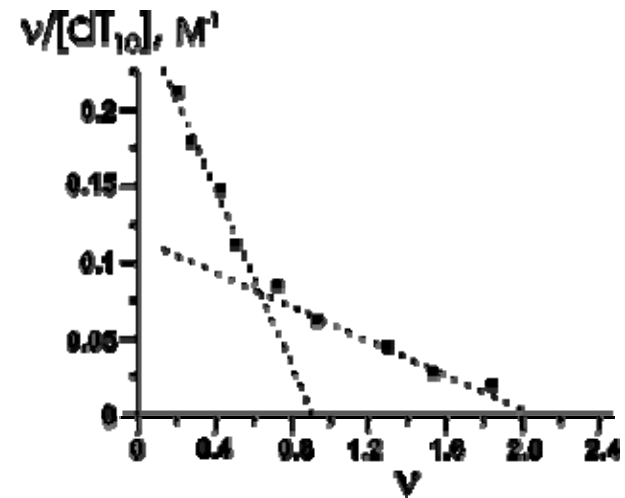
*Ann. NY. Acad. Sci.*

1949



## THE ATTRACTIONS OF PROTEINS FOR SMALL MOLECULES AND IONS

Determination of binding  
constants from  
experimental data



# **A CASE STUDY IN FAULTY GRAPHICAL TREATMENT**

## **The Scatchard and Eadie–Hofstee plots**

**Some years ago we examined a considerable number of papers published in major biochemical journals around 1993–1994 that presented Scatchard plots in which the data points could not be interpreted as straight lines. Of these, around 30% used computational methods and included sufficient evidence to suggest that they had been applied appropriately and correctly. The majority, however, used graphical methods in ways that were demonstrably incorrect and likely to produce significant errors both in the qualitative interpretation of the data and in the values of any binding or kinetic constants estimated.**

**Athel Cornish-Bowden**

# Citation History

Paper	SCI Total 1988	SCI Total 2004	Average Yearly Citation upto 1988	Annual Citation For 1988	Average yearly Citation 1989-2004
Lowry	187652	275669	4938	9750	5501
Laemlli	59759	182288	3145	8896	7658
Bradford	24366	107583	1874	4303	5201
Sanger	10718	61041	893	3258	3145

# Recognition and Impact of Methods

• Citation counts

• Nobel prizes

- Widely used laboratory procedures (Lowry, Laemlli, Southern.....)
- Conceptual advance resulting in a powerful instrumental technique (X- Ray diffraction, NMR, Mass Spectrometry.....)

Gene cloning,

DNA sequencing,

PCR.....

**Science is often driven by new technology  
rather than by new concepts**

**- FREEMAN DYSON**

# X-Ray Crystallography



- 1915**      **Physics**                      **W. H. BRAGG** and **W. L. BRAGG**  
*.....analysis of crystal structure by means of X-rays*
- 1962**      **Chemistry**                      **M. F. PERUTZ** and **J. C. KENDREW**  
*.....studies of the structures of globular proteins*
- 1964**      **Chemistry**                      **D. C. HODGKIN**  
*.....determinations by X-ray techniques of the  
structures of important biochemical substances*
- 1985**      **Chemistry**                      **J. KARLE** and **H. A. HAUPTMAN**  
*.....development of direct methods for the  
determination of crystal structures*

# NMR - Spectroscopy



- 1944**      **Physics**      **I. I. RABI**  
*.....resonance method for recording the magnetic properties of atomic nuclei.*
- 1952**      **Physics**      **F. BLOCH and E. M. PURCELL**  
*.....new methods for nuclear magnetic precision measurements and discoveries in connection therewith*
- 1991**      **Chemistry**      **R. R. ERNST**  
*.....high resolution nuclear magnetic resonance (NMR) spectroscopy*
- 2002**      **Chemistry**      **K. WÜTHRICH**  
*.....nuclear magnetic resonance spectroscopy for determining the three-dimensional structure of biological macromolecules in solution*
- 2003**      **Physiology or Medicine**      **P. C. LAUTERBUR and P. MANSFIELD**  
*..... discoveries concerning magnetic resonance imaging*



# Mass Spectrometry



**1906**

**Physics**

**J. J. THOMSON**

*.....theoretical and experimental investigations on the conduction of electricity by gases*

**1922**

**Chemistry**

**F. W. ASTON**

*.....discovery, by means of the mass spectrograph, of isotopes, in a large number of non-radioactive elements, and for the enunciation of the whole-number rule.*

**1989**

**Physics**

**W. PAUL and H. G. DEHMELT**

*.....for the development of the ion trap technique*

**2002**

**Chemistry**

**K.TANAKA and J. B. FENN**

*.....development of soft desorption ionisation methods for mass spectrometric analyses of biological macromolecules*



# The Journal Impact Factor

- A Double Edged Sword

## The Impact Factor : Views and Evaluation

K. Bhatia and D.N. Gandhi, *J. Inf Mgmt.* 40, 179-198 (1993)

$$IF_{2003} = \frac{\text{2003 citations to articles publ. in 2001-2002}}{\text{Number of articles publ. in 2001-2002}}$$

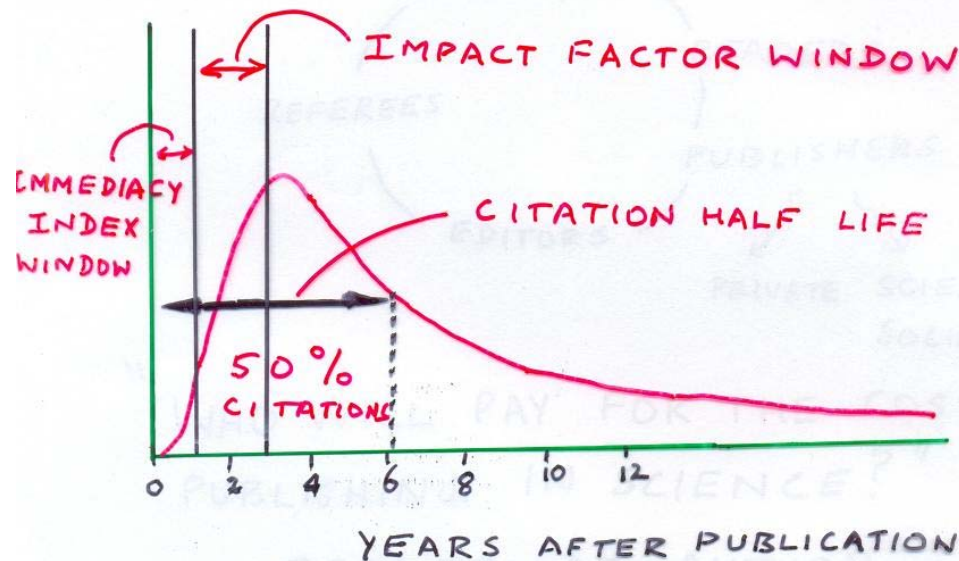
1. Ranking of Journals
2. Ranking of Institutions and Individuals (The Insidious “Average Impact Factor”)
3. Effects on the “Mores of Publishing Science”

# Citation Counting

Impact Factors : Use and Abuse

- M. Amin & M. Mabe

Perspectives in Publishing Elsevier Science (News letter for Journal editors)



**Subject variation in impact factors** (Mean "IF" 1998)

Life Sci. ~ **3.0**

Physics ~ **1.5**

Maths/Comp.Sci. ~ **0.5**

Earth Sci. ~ **1.1**

Chemistry/Chem Eng. ~ **1.5**

Materials Sci/Eng. ~ **0.6**

# Citation Tracking – Sociology of Science

**“Mapping Fields”** By Cluster Analysis

**Impact Factors** have begun to influence the sociology of science

**“Directed Citation”**

Authors

Referees

Editors

1. **“Citability”** of Indian Journals (Accessibility)
2. **“Interoperability”** (Digital “ Services “ that talk to each other)

**Interoperability of the sciences**

## **1. Authorship Issues**

- First Author Syndrome
- Honorary Authors

## **2. Scientific collaboration**

- Credit and Responsibility

## **3. Influencing the publication process**

## **4. Citing the Literature**

**“The Lost Science of the Third World”**

## “Who wrote this paper anyway”?

- J. Hoey *Can.Med.Ass.J.* 2000, **163**:716

### **Pancreatic extracts in the treatment of diabetes mellitus.**

Preliminary report **F.G. Banting, C.H. Best, J.B. Collip, W.R. Campbell and A.A. Fletcher** *Can.Med.Ass.J.* 1922, **22**:141

“**Discovery of Insulin**” 1922 – **Nobel Prize in Medicine F.G. Banting and John Macleod**

“ ... **The corollary of credit is the ability to take responsibility for what is written. These are the twin attributes of authorship**”

# Open archives

a) **Bulletin Boards** – The example of Physics (~1990s)

b) **Institutional Archives**

- Management of Technology
- Breaking psychological barriers and addressing imaginary fears of scientists
- Building a robust interface between the “**Information Generators**” and “**Information Handlers**”.

**Dynamics of storing and retrieving published material or public domain thesis, reports**

**Open archives** are “**openly accessible**”

# Open Access

Journal

E-print Archives

## Who will pay for publishing?

**Authors**

or

**Readers**

Page Charges

Free Publication

Reprint Costs

Free Reprints

Colour Printing

Free Colour (Editor Discretion)

**Society Journals**

**Private Publishers**

Public library of science: **PLOS Biology**

Estimated cost of a paper \$ 1500.....\$3000

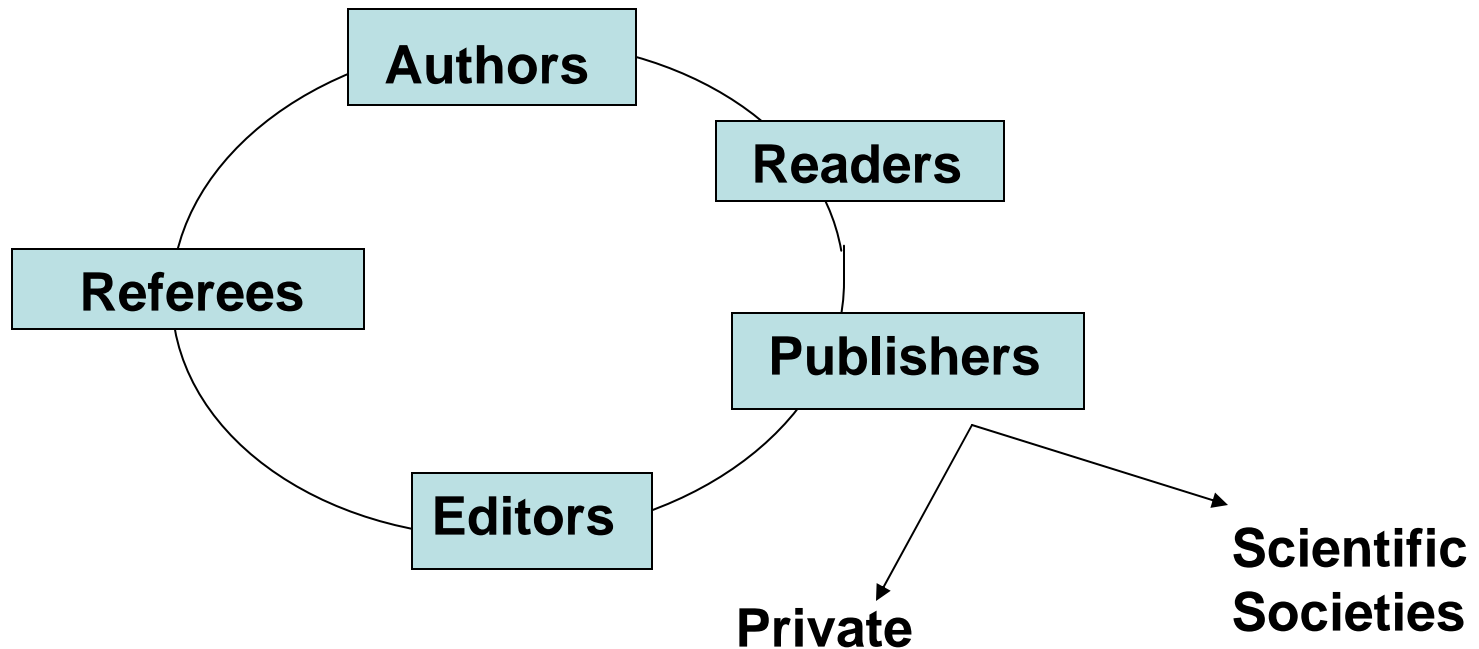
# Open Access Journals

**Commercial Publishers  
(including societies)**

**Vs**

**White knights of the  
Scientific community**

## The case of “PLOS Biology”





# Academic Ranking of World Universities – 2003

N.C. Liu *et al.* Shanghai

**Methodology** (5 parameters, 21 Subject categories)

(Life Sci., Medicine, Phys. Sci., Engineering and Social Sciences)

1. **Nobel Laureates** (Differential weight for award dates)
2. **Papers in Nature and Science** (2000-2002)
3. **Highly cited researchers 1981-1999**
4. **Articles in SCI (Exp) and Social Science Ci.**
5. **Academic performance (1-4) per faculty**

## The List (Top 500)

- 1. Harvard
  - 2. Stanford
  - 3. Caltech
  - 4. Berkeley
  - 5. Cambridge
  - 6. MIT
  - 7. Princeton
  - 8. Yale
  - 9. Oxford
  - 10. Columbia
- 19. Univ. Tokyo
  - 25. ETH, Zurich
  - 251-300 IISc
  - 451-500 IIT Delhi
  - IIT Kharagpur

# The scientific impact of nations

- D.A. King *Nature* 2004 430 : 311 (July 15 issue)

Rank order	Nations	1997-2001	Share of Top 1% cited publications
1	USA	23723	62.76
2	UK	4831	12.78
3	GERMANY	3932	10.4
4	JAPAN	2609	6.9
5	FRANCE	2591	6.85
6	CANADA	2195	5.81
7	ITALY	1630	4.31
.			
19	CHINA	375	0.99
20	S. KOREA	294	0.78
21	POLAND	231	0.61
22	INDIA	205	0.54
	Total	38,263	136.5 Collaboration

# 'h index' : Comparing Performance

An index to quantify an individual's scientific research output

J.E. Hirsch arXiv : physics/0508025 23 Aug 2005

PNAS | November 15, 2005 | vol. 102 | no. 46 | 16569-16572

“A scientist has index  $h$  if  $h$  of his/her  $N_p$  papers have at least  $h$  citations each and the other  $(N_p - h)$  papers have fewer than  $h$  citations each”.

$N_p$  -total number of papers over n years

$N_c^j$  -number of citations for each paper j

$N_{c, tot}$  -total number of papers

$$N_{c, tot} = ah^2$$

“Empirically, ‘a’ ranges from 3 to 5”

“h is preferable to other single number criteria commonly used to evaluate scientific output of a researcher”.

# Quantitation of Individual Output

- i. **Total number of papers ( $N_p$ )**. Measures productivity; Does not measure impact
- ii. **Total citations ( $N_{c, tot}$ )**. Measures total impact; Inflated by small number of big hits (co-authorship issues). Leads to 'a' values  $>5$ . Weightage to review articles which are usually more cited.
- iii.  **$N_{c, tot} / N_p$**  Allows comparisons of scientists of different ages; rewards low productivity, penalizes high productivity
- iv. **Number of significant papers ( $> 'y'$  citations)**  
Indicator of broad sustained impact; 'y' arbitrary and needs 'seniority adjustment '.

## Long term impact

$$h \sim mn \text{ (n, number of years)}$$

Parameter 'm' is useful for scientist who maintain long term productivity

### The diagnosis

1.  $m \sim 1$ ,  $h=20$  after 20 years "Successful Scientists"
2.  $m \sim 2$ ,  $h=40$  after 20 years "outstanding scientists" .... ' likely to be found in top universities or major research laboratories
3.  $m \sim 3$ ,  $h=60$  (20 years) or  $h=90$  (30 years) "truly unique individuals"

### The prescription ("with large error bars")

1.  $h \sim 12$ , tenure at a US University
2.  $h \sim 15-20$ , fellowship in the American Physical Society
3.  $h \sim 45$ , U.S. National Academy of Sciences

# Lessons of the h index

**Physics Nobel prizes** (last 20 years)

'h' (median) = 35

84 % had 'h'  $\geq$  30

**“Nobel prizes do not originate in one stroke of luck but in a body of scientific work”.**

49 % had m < 1

**“ This is clearly because Nobel prizes are often awarded long after the period of maximum productivity of the researchers “.**

**'h'** indices will be discipline dependent.

**'.....the growth of science is dependent upon an accumulation of many "mediocre" results that are produced by hard work'.....**

**....'Long live the mediocrities. Without them how could there be geniuses?'**

**Garfield, E., *Current Contents* Nov. 4, 1970;  
*Essay of an Information Scientist*,  
ISI Press, Philadelphia, 1977, p. 131**



<b>S.No</b>	<b>Institution</b>	<b>Papers (2001-2005)</b>	<b>'h' Index</b>	<b>Number of citations</b>	
				<b>Paper No. 50</b>	<b>Paper No. 100</b>
<b>1</b>	<b>Harvard University</b>	<b>54037</b>	<b>195</b>	<b>374</b>	<b>271</b>
<b>2</b>	<b>University of Toronto</b>	<b>29367</b>	<b>108</b>	<b>156</b>	<b>113</b>
<b>3</b>	<b>Stanford University</b>	<b>27372</b>	<b>145</b>	<b>261</b>	<b>186</b>
<b>4</b>	<b>Univ. California at Berkeley</b>	<b>24073</b>	<b>136</b>	<b>232</b>	<b>161</b>
<b>5</b>	<b>University of California San Diego</b>	<b>23951</b>	<b>138</b>	<b>241</b>	<b>171</b>
<b>6</b>	<b>University of Maryland</b>	<b>23653</b>	<b>94</b>	<b>142</b>	<b>93</b>
<b>7</b>	<b>Cambridge University</b>	<b>23210</b>	<b>121</b>	<b>184</b>	<b>134</b>
<b>8</b>	<b>Columbia University</b>	<b>22622</b>	<b>121</b>	<b>175</b>	<b>129</b>
<b>9</b>	<b>Tohoku University</b>	<b>21656</b>	<b>72</b>	<b>88</b>	<b>64</b>
<b>10</b>	<b>Oxford University</b>	<b>21091</b>	<b>120</b>	<b>190</b>	<b>190</b>
<b>11</b>	<b>Univ. California at Davis</b>	<b>20859</b>	<b>88</b>	<b>118</b>	<b>83</b>
<b>12</b>	<b>Yale University</b>	<b>20705</b>	<b>133</b>	<b>193</b>	<b>149</b>
<b>13</b>	<b>M.I.T.</b>	<b>19423</b>	<b>146</b>	<b>270</b>	<b>172</b>
<b>22</b>	<b>California Institute of Tech.</b>	<b>13374</b>	<b>115</b>	<b>174</b>	<b>123</b>

<b>S.No.</b>	<b>Institution</b>	<b>Papers (2001- 2005)</b>	<b>‘h’ Index</b>	<b>Number of citations</b>	
				<b>Paper No. 50</b>	<b>Paper No. 100</b>
<b>14</b>	<b>Tsing Hua University</b>	<b>18553</b>	<b>45</b>	<b>44</b>	<b>33</b>
<b>16</b>	<b>Seoul National University</b>	<b>17883</b>	<b>64</b>	<b>72</b>	<b>46</b>
<b>17</b>	<b>University of Vienna</b>	<b>16392</b>	<b>70</b>	<b>77</b>	<b>60</b>
<b>18</b>	<b>National Taiwan University</b>	<b>14825</b>	<b>52</b>	<b>52</b>	<b>37</b>
<b>19</b>	<b>University of Helsinki</b>	<b>14784</b>	<b>90</b>	<b>120</b>	<b>84</b>
<b>20</b>	<b>Peking/Beijing University</b>	<b>14429</b>	<b>51</b>	<b>53</b>	<b>37</b>
<b>21</b>	<b>National University of Singapore</b>	<b>14216</b>	<b>53</b>	<b>54</b>	<b>41</b>
<b>24</b>	<b>University of Manchester</b>	<b>13182</b>	<b>70</b>	<b>85</b>	<b>58</b>
<b>25</b>	<b>Karolinska Institute Stockholm</b>	<b>12826</b>	<b>80</b>	<b>96</b>	<b>75</b>
<b>26</b>	<b>University of Uppsala</b>	<b>12138</b>	<b>78</b>	<b>101</b>	<b>68</b>
<b>27</b>	<b>University of Sidney</b>	<b>12056</b>	<b>64</b>	<b>71</b>	<b>54</b>
<b>30</b>	<b>University of Padua</b>	<b>11503</b>	<b>67</b>	<b>88</b>	<b>53</b>
<b>40</b>	<b>Korea Institute of Science and Tech</b>	<b>7604</b>	<b>46</b>	<b>43</b>	<b>30</b>
<b>47</b>	<b>Indian Institute of Science</b>	<b>5081</b>	<b>37</b>	<b>31</b>	<b>22</b>

# National Statistics (2001 – 2005)

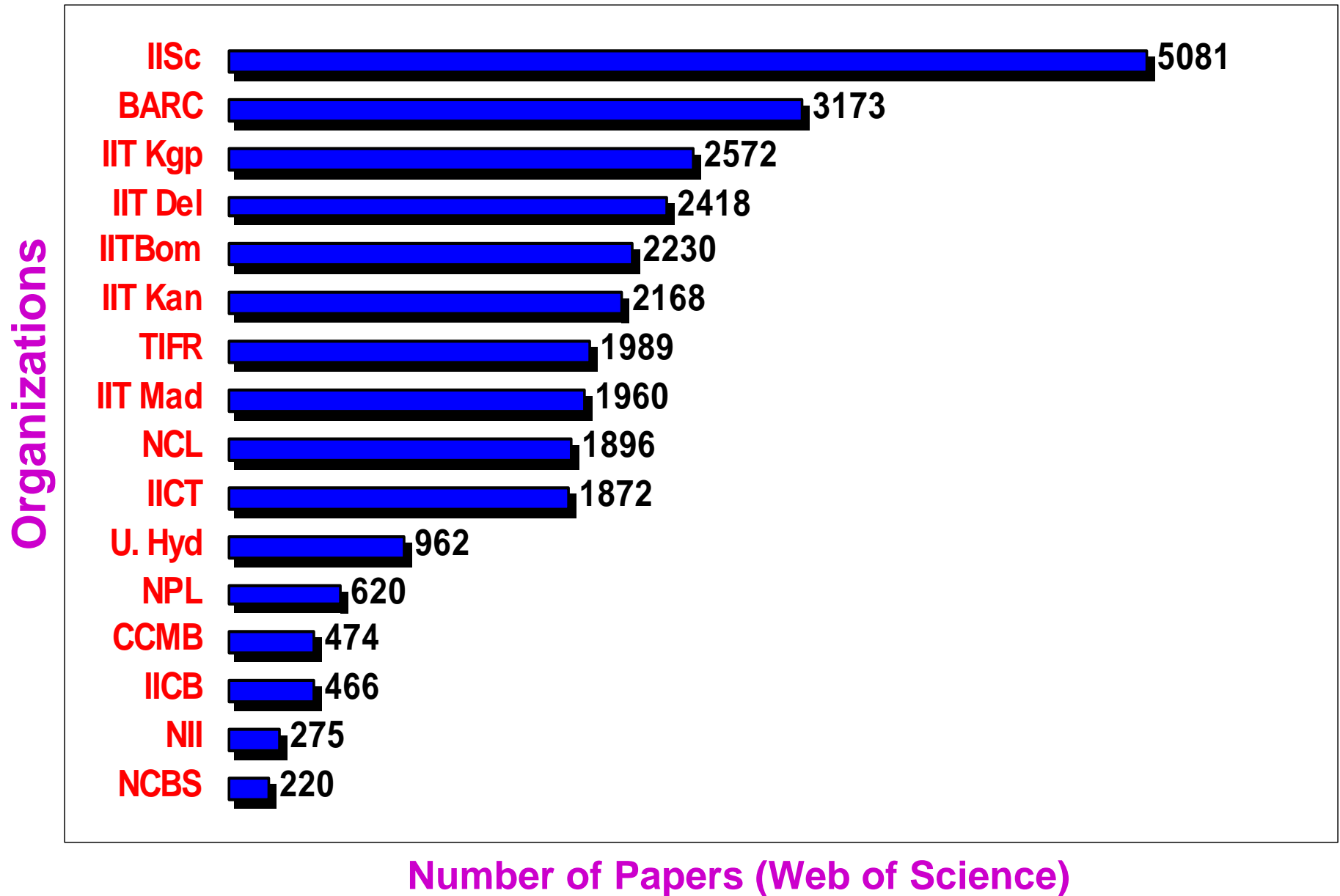
Updated March 11, 2006

<b>S.No</b>	<b>Institutions</b>	<b>Papers</b>	<b>% India</b>	<b>Citations</b>	<b>Citations /paper</b>	<b>“h” Index</b>
1	IISc	5081	4.4	17166	3.3	37
2	BARC	3173	2.7	9810	3.1	36
3	IIT BOM	2230	1.9	5635	2.5	22
4	IIT DEL	2418	2.1	4262	1.7	19
5	IIT KAN	2168	1.8	6008	2.7	25
6	IIT KGP	2572	2.2	5185	2.0	21
7	IIT MAD	1960	1.7	3141	1.6	17
8	TIFR	1989	1.7	12727	6.3	38
9	NCL	1896	1.6	8235	4.3	28
10	IICT	1872	1.6	7869	4.2	28
11	UNIV. HYDER	962	0.8	4733	4.9	27
12	NPL	620	0.5	1536	2.4	15
13	CCMB	474	0.4	1990	4.1	18
14	IICB	466	0.4	1367	2.9	15
15	NII	275	0.2	1021	3.7	15
16	NCBS	220	0.2	1840	8.3	21

## Percentage Contribution to National Publication Output

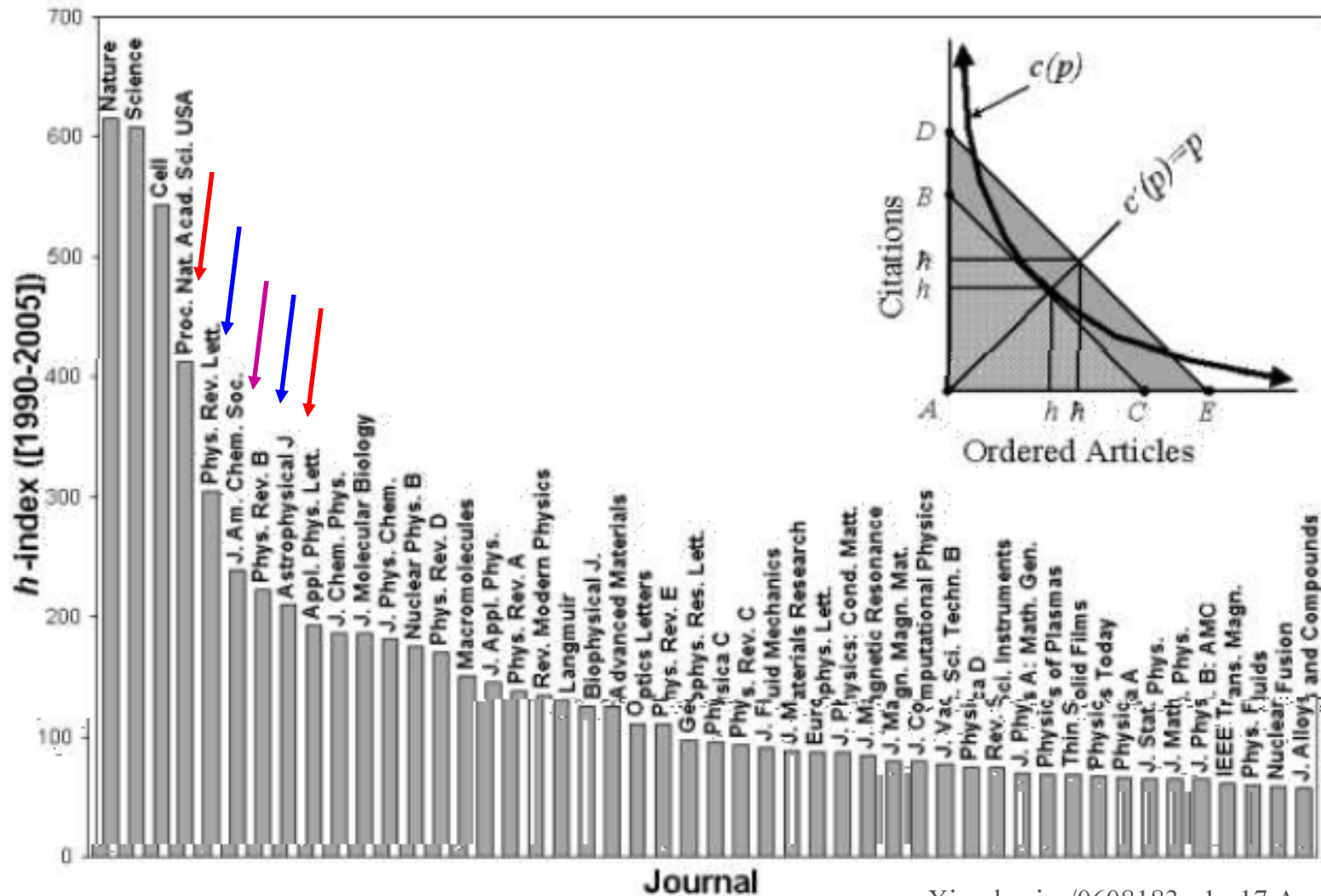
<b>S.No</b>	<b>INST.</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>All 5 years</b>
1	IISc	4.83	4.60	4.49	4.18	4.25	4.44
2	BARC	2.96	3.12	2.81	2.78	2.33	2.77
3	IIT BOM	1.94	1.89	1.82	2.06	2.01	1.95
4	IIT DEL	1.91	1.90	2.18	2.22	2.26	2.12
5	IIT KAN	1.76	1.86	1.88	2.00	1.93	1.90
6	IIT KGP	2.23	2.11	2.11	2.40	2.34	2.25
7	IIT MAD	1.59	1.54	1.67	1.73	1.95	1.71
8	TIFR	1.90	1.97	1.54	1.67	1.67	1.74
9	NCL	1.82	1.60	1.61	1.69	1.59	1.66
10	IICT	1.39	1.52	1.69	1.77	1.73	1.64
11	UNIV. HYD	0.87	0.87	0.78	0.79	0.88	0.84
12	NPL	0.57	0.53	0.55	0.55	0.50	0.54
13	CCMB	0.36	0.37	0.36	0.49	0.45	0.42
14	IICB	0.38	0.38	0.42	0.41	0.42	0.41
15	NII	0.29	0.23	0.24	0.21	0.22	0.24
16	NCBS	0.15	0.14	0.18	0.27	0.19	0.19

## Published Papers (2001 – 2005), India



# Superiority of the h-index over the Impact factor for Physics

Casey W. Miller



## A Hirsch-type index for journals (Journals with the highest h-index for their 2001 papers)

Ranked by h-index	Journal Title	Journal H-index	Rank by 2001 Impact factor
1	<i>Nature</i>	157	10
2	<i>Science</i>	155	13
3	<i>New England J. Med.</i>	113	5
4	<i>PNAS, USA</i>	113	55
5	<i>Cell</i>	109	3
6	<i>JBC</i>	100	95
7	<i>Physical Rev. Let</i>	96	118
8	<i>Lancet</i>	89	60
9	<i>Circulation</i>	86	54
10	<i>Nature Genetics</i>	85	4
11	<i>J. Am. Med. Ass.</i>	80	26
12	<i>Cancer Research</i>	79	8
13-14	<i>Nature Medicine</i>	78	6
13-14	<i>J. Immunology</i>	78	109
15-16	<i>Neuron</i>	77	29
15-16	<i>J. Cell Biology</i>	77	36
17-19	<i>J. Clinical Investigation</i>	76	48
17-19	<i>Blood</i>	76	75
17-19	<i>Astrophysical J.</i>	76	511
20-21	<i>Nature Neuroscience</i>	75	44
20-21	<i>JACS</i>	75	133

# Challenges in Creating World Class Educational (Research) Institutions

- Enabling role of Government
- Organizational Imperatives
- Role of Academic Leadership
- Academic and Infrastructure Enablers to Identify and Foster Talent
- Governing Mechanisms
- Funding
- Indian Experience

**Higher Education** : **Public or private ?**

**Research** : **Public Funding**



## **Indian Institutes of Management (IIM)**

- **Student Selection**
- **Placement Performance**
- **Alumni**
- **Industry - Interface**

## **Indian Institutes of Technology (IIT)**

- **Student Selection**
- **Undergraduate Engineering Education**
- **Post-graduate Teaching / Research**
- **Alumni ..... “ Brand Equity”**
- **IIT Review 2004**

## **Indian Institute of Science (IISc)**

- **Post-graduate Teaching / Research**
- **Science and Engineering**
- **Faculty Research Emphasis / PhD degrees**
- **Life Sciences**

**Indian Institutes of Science Education and Research (IISER) – Pune / Kolkata**

**Undergraduate Science Education in a Research Ambience**

# Models

## Research Universities

- **Harvard, Stanford, Berkeley, Cambridge, Oxford .....**  
**Faculty and Student Scholarship**
- **Indian Models**  
**Kolkata, Madras, Delhi, Banaras, Allahabad .....**

**Pre-independence : Primarily Teaching**

**Post-independence :**

**1950s – 1960s ---- Surge of Research**

**1970s ---- Accelerating Decay of Research**

- **Specialist Laboratories versus the Broad – Based Institution**

**Small or Large ??**

# Creating an Ambience

- **Governance**
  - Institution Building
  - Consolidation
  - Expansion / Modernization
- **Faculty / Student Performance**
  - Evaluation
  - Carrot and Stick (Tenure and Rewards)
- **Research Facilities**
  - Funding
  - Development Corpus
- **Promoting Scholarship**
  - Academic Debate
  - Participatory Governance
  - Interdisciplinary Dialogue

# Parameters of Institutional Performance

- **Students Trained / Degrees Awarded**  
Performance of Alumni
- **Research Papers Published**  
Impact
- **Intellectual Property**  
Patents / Technology Transfer  
Licensing / Royalty Income
- **Resources Generated**  
Magnitude of Corpus

# The Median Isn't the Message

- Stephen Jay Gould

## Mark Twain's famous quip

(sometimes attributed to Disraeli)

-- "Identifies three species of mendacity, each worse than the one before – lies, damned lies, and statistics".

**“Statistics are the triumph of the quantitative method,  
and the quantitative method is the victory of sterility  
and death”.**

**- Hilaire Belloc**

**“ A little learning is a dangerous thing;  
Drink deep, or taste not the Pierian spring;  
There shallow draughts intoxicate the brain, and  
Drinking largely sobers us again”.**

**- Alexander Pope**

# Measures for measures

S. Lehmann, A. D. Jackson and B. E. Lautrup  
Nature, Vol. 444, 1003, 2006 (Dec 21/28)

**“There have been few attempts to discover which of the popular citation measures is best and whether any are statistically reliable.”**

**“ Institutions have a misguided sense of the fairness of decisions reached by algorithm ; unable to measure what they want to maximize (quality), they will maximize what they can measure”**

# Correlating the Uncorrelated

**Decline of Science in India Correlates with  
Improvement in Technology**

**Swaminathan Aiyar, Times of India**

**Decline in Indian Political Standards Correlates  
with Improvement in the Indian Economy**

**(Anonymous)**