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”

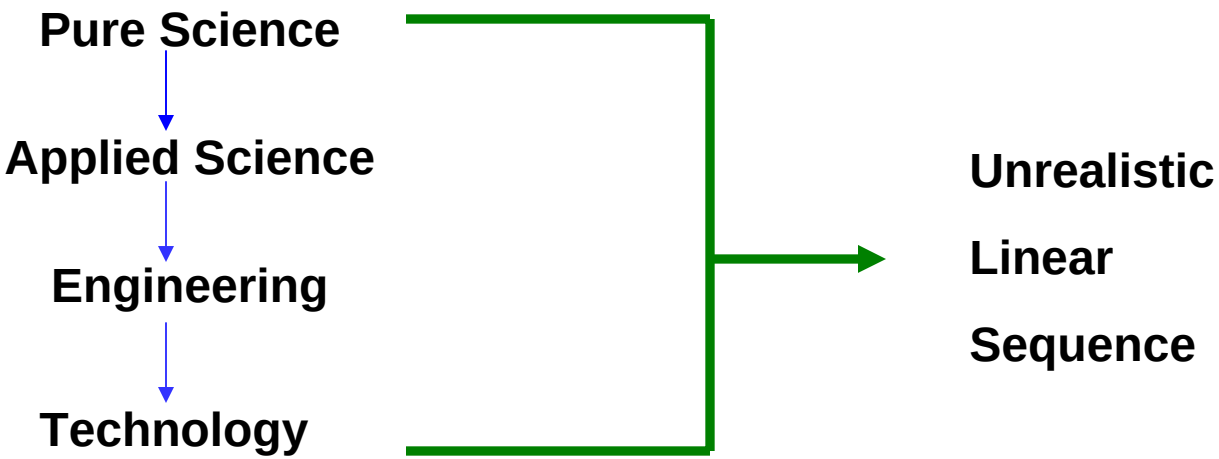
Science by itself provides no panacea for individual, social and economic ills. It can be effective in national welfare only as a member of a team. But without scientific progress, no amount of achievement in other directions can insure our health, prosperity and security.

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

↓

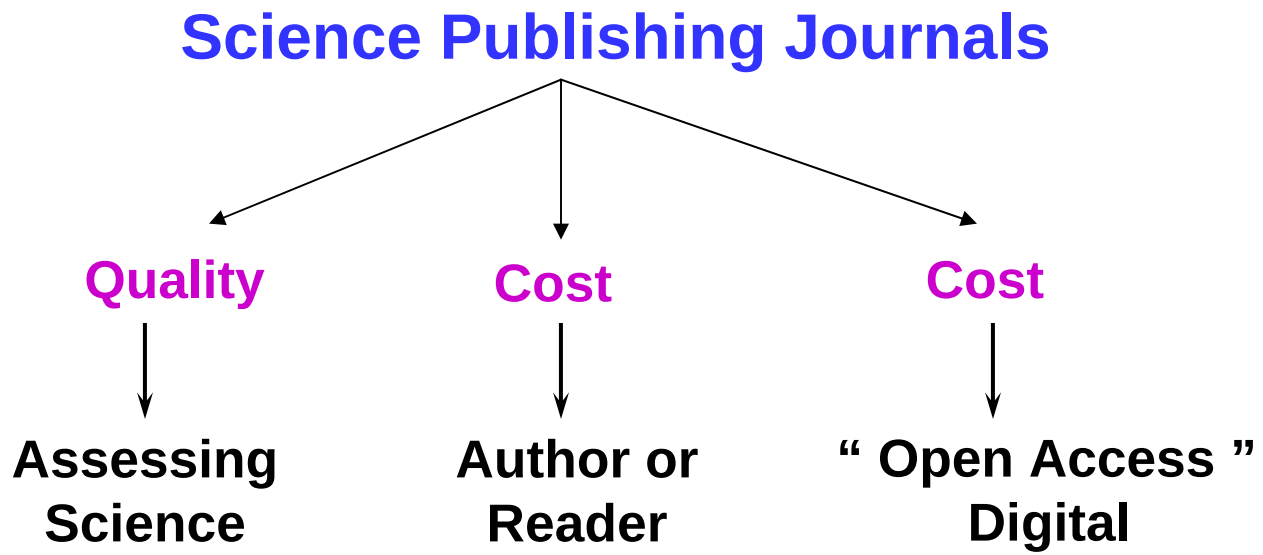
Web of Science

Science, Scientists and Scientometrics

Man is an Animal that writes Letters

– Charles Dodgson (Lewis Carroll)

Scientists are animals who like to publish papers



HISTORY

Current Contents

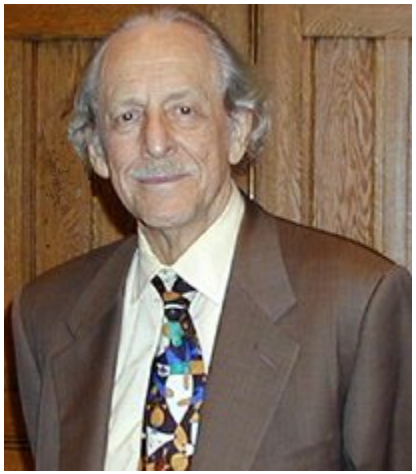
↓

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"

938NE

INTERCIENCIA

INTERCIENCIA

MULTILINGUAL JOURNAL-EACH ABSTRACT IN ENGLISH, SPANISH AND PORTUGUESE

VOL.30 NO.6 JUNE 2005

ARTICLES

EDITORIALS

942QJ

NATURE

NATURE PUBLISHING GROUP

ARTICLES AND ABSTRACTS IN ENGLISH

VOL.436 NO.7047 JULY 7 2005

ARTICLES

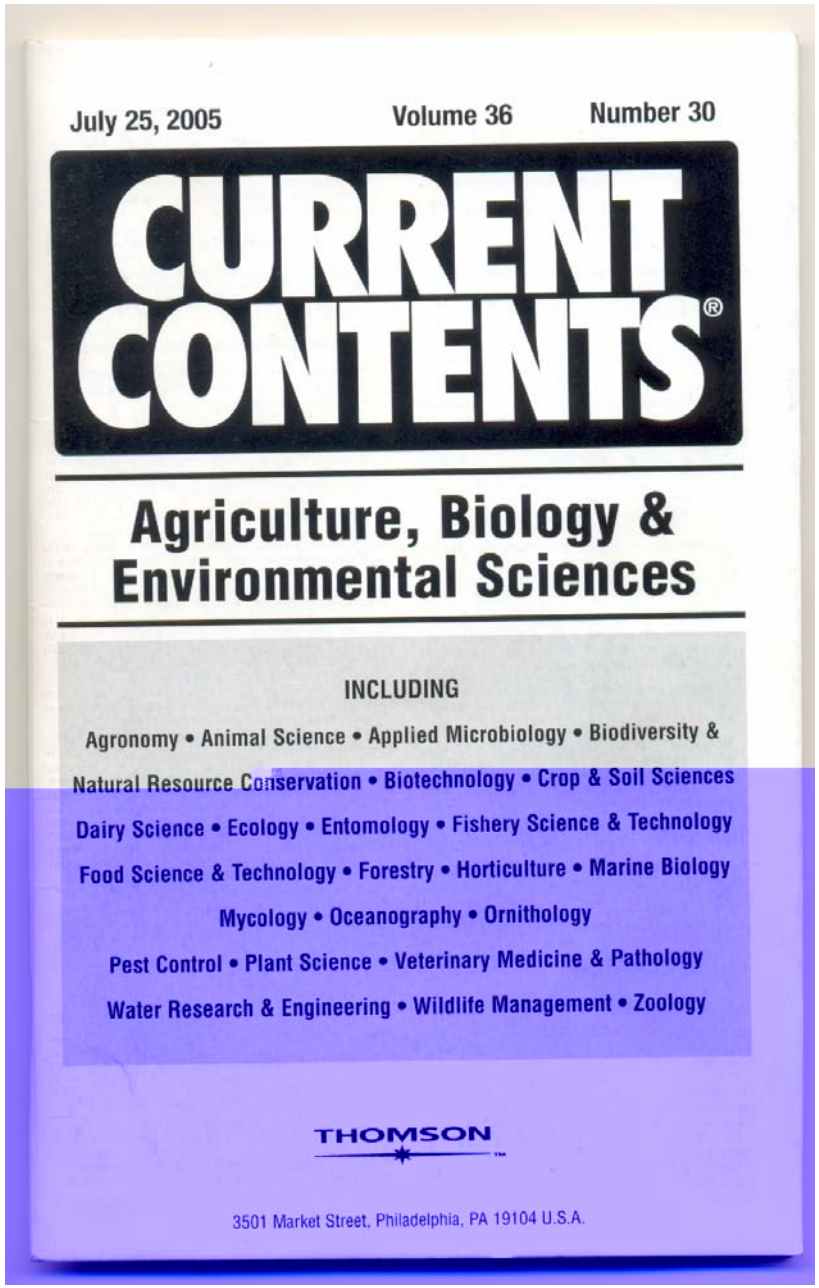
CONTINUED

BOOK REVIEWS

CORRECTIONS

EDITORIALS

CONTINUED


July 25, 2005
Volume 36
Number 30
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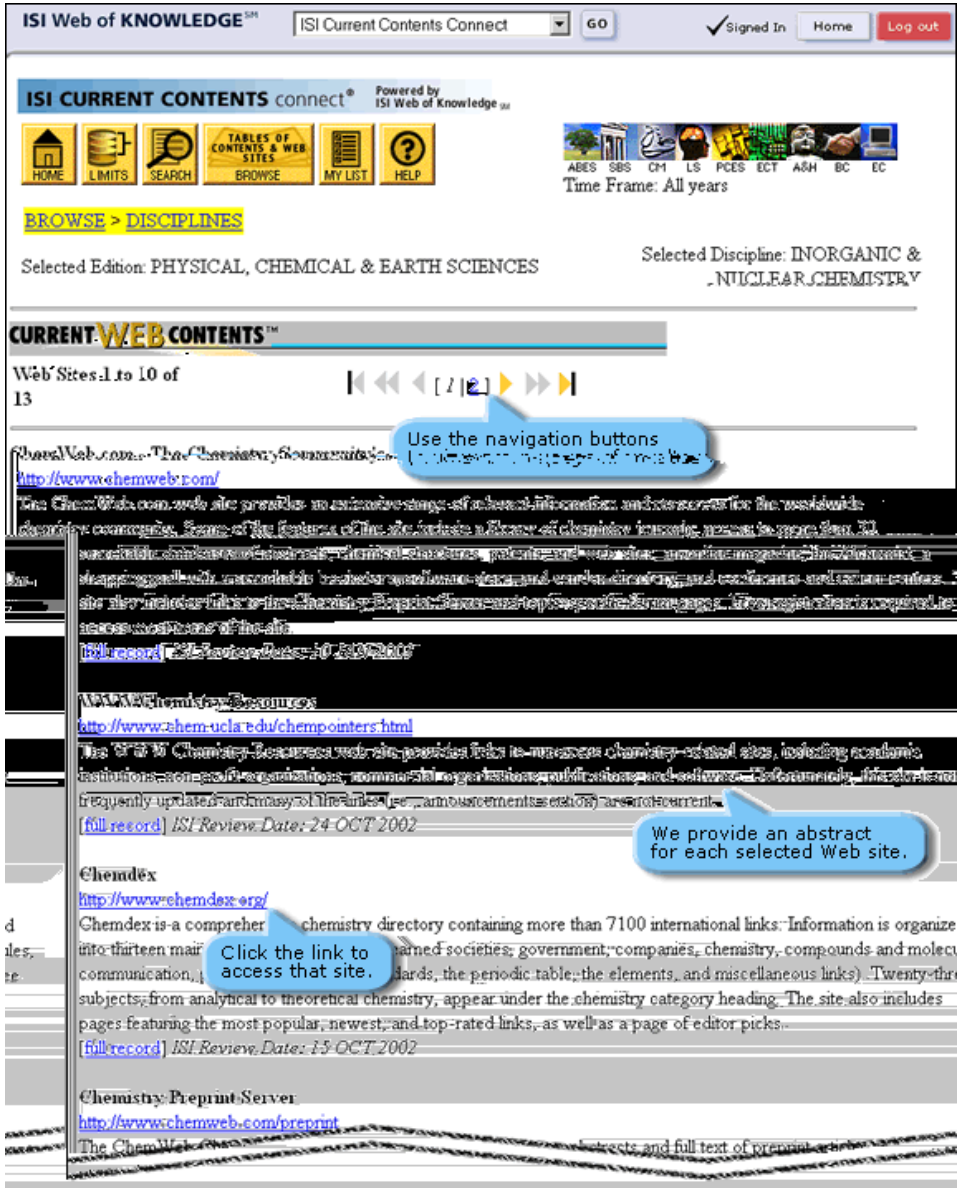
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Web Sites 1 to 10 of 13
Use the navigation buttons
http://www.chemweb.com/
[full record] ISI Review Date: 24-OCT-2002
http://www.chem.ucla.edu/chempointers.html
We provide an abstract for each selected Web site.
Chemdex
http://www.chemdex.org/
Click the link to access that site.
Chemdex is a comprehen chemistry directory containing more than 7100 international links. Information is organize
into thirteen mair named societies, government, companies, chemistry, compounds and molecu
communication, dards, the periodic table, the elements, and miscellaneous links). Twenty-thr
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
Chemistry Preprint Server
http://www.chemweb.com/preprint
The ChemWeb

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

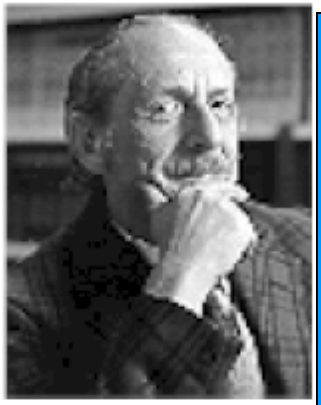

Table 1: Citation frequency distribution for papers in the *SCI*®, 1945-1988. A = number of citations. B = number of items receiving that number of citations. C = percent of entire *SCI* file.

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
TOTAL	32,728,729	100.00

* = 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

O Citations : 82.00 %
<10 Citations : 16.02 %

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

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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 $c \longrightarrow 2$

"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 γ of protein.

Method

Reagents—Reagent A, 2 per cent Na_2CO_3 in 0.10 N NaOH. Reagent B, 0.5 per cent $CuSO_4 \cdot 5H_2O$ 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 γ 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"

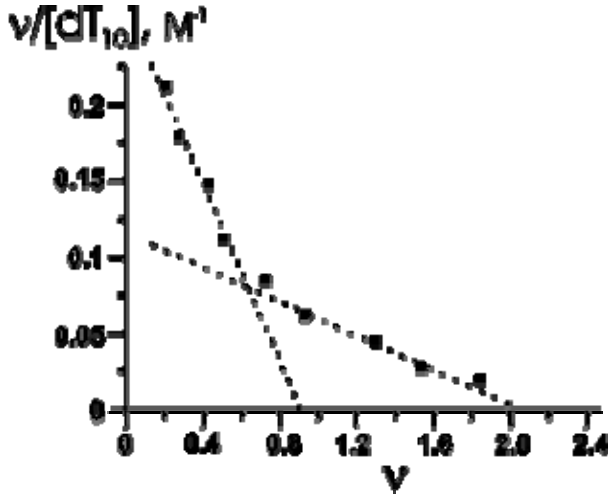
New York Herald Tribune
August 12, 1948

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

http://bip.cnrs-mrs.fr/bip10/metha3.htm

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)

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

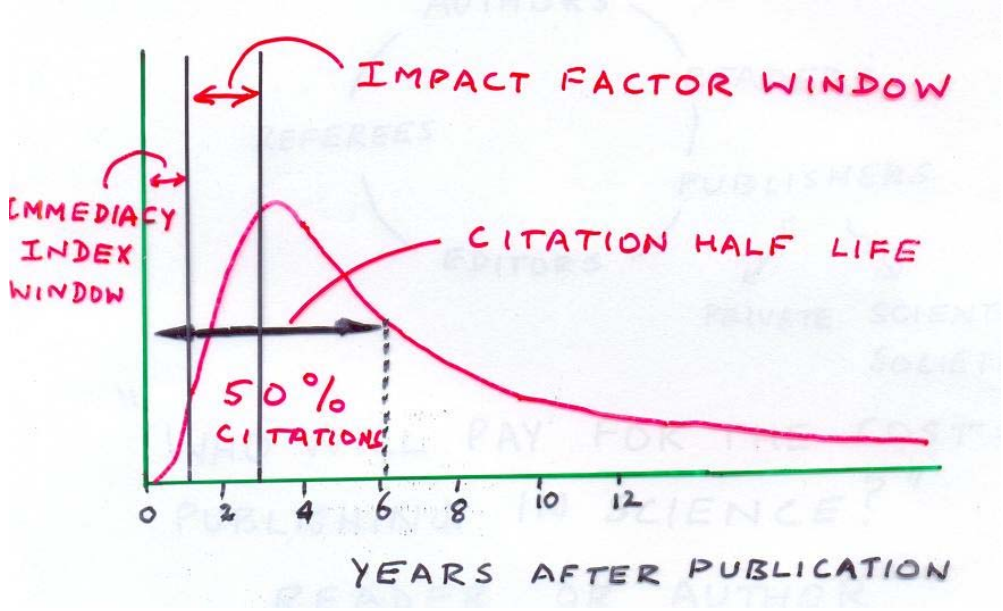
1. **Ranking of Journals**
2. **Ranking of Institutions and Individuals (The Insidious " Average Impact Factor ")**
3. **Effects on the " Mores of Publishing Science "**

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**

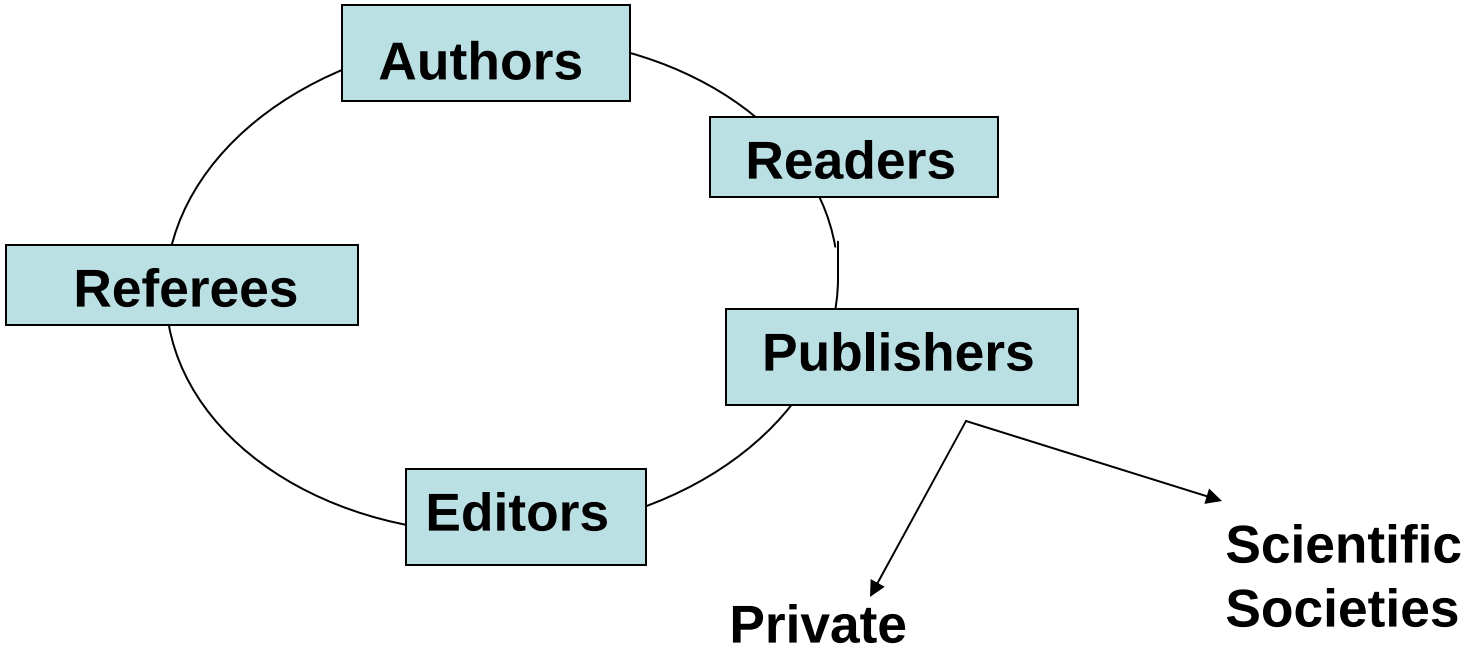
Public library of science: PLOS Biology

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**

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19. Univ. Tokyo

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25. ETH, Zurich

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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 ~ mn (n, number of years)

Parameter ‘m’ is useful for scientist who maintain long term productivity

The diagnosis

1. m ~ 1, h=20 after 20 years “Successful Scientists“
2. m ~ 2, h=40 after 20 years “outstanding scientists“ **....** ‘ likely to be found in top universities or major research laboratories
3. m ~ 3, h=60 (20 years) or h=90 (30 years) “truly unique individuals”

The prescription (“with large error bars”)

1. h ~ 12, tenure at a US University
2. h ~ 15-20, fellowship in the American Physical Society
3. h ~ 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

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

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

National Statistics (2001 – 2005)

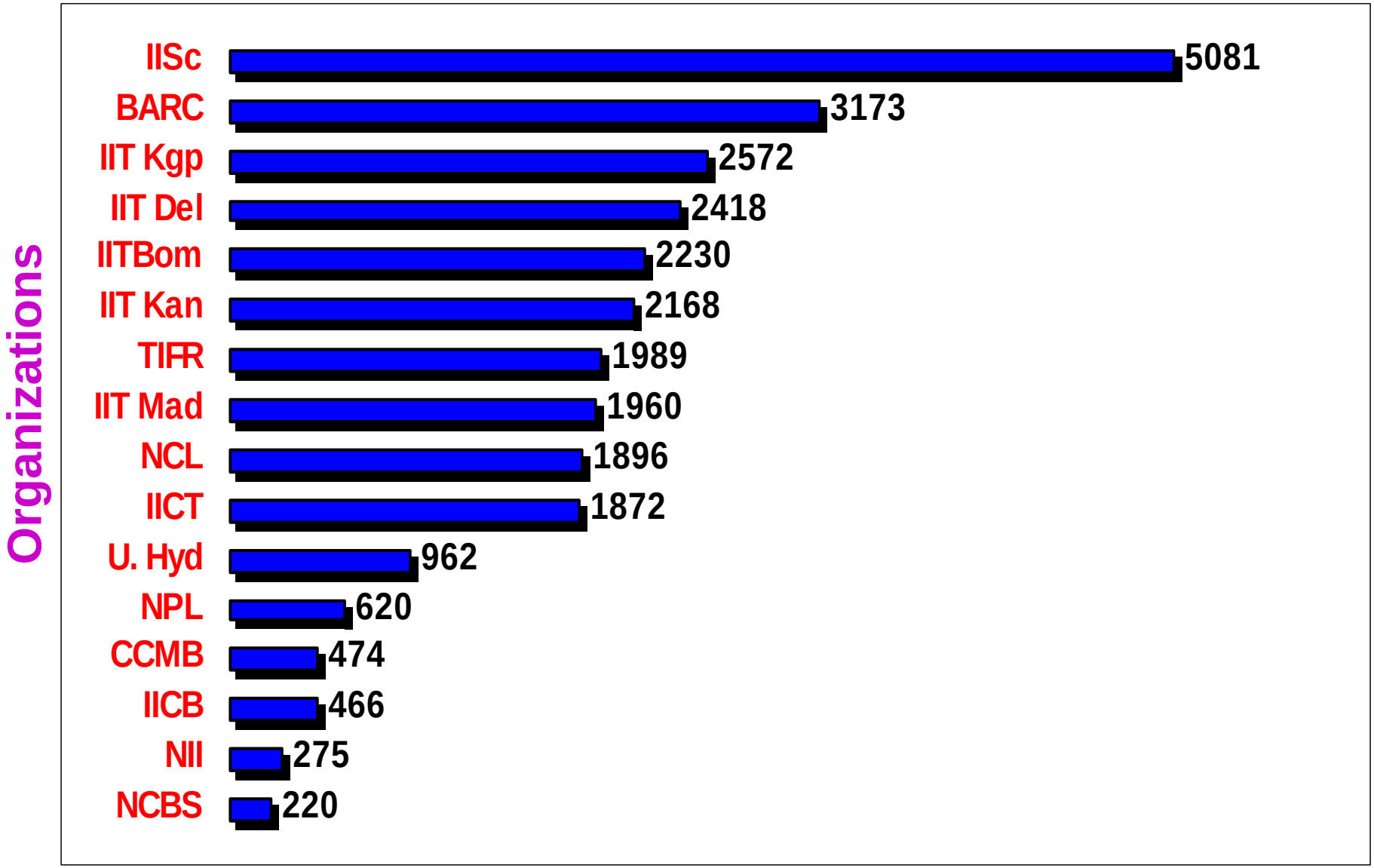
Updated March 11, 2006

S.No	Institutions	Papers	% India	Citations	Citations /paper	"h" Index
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

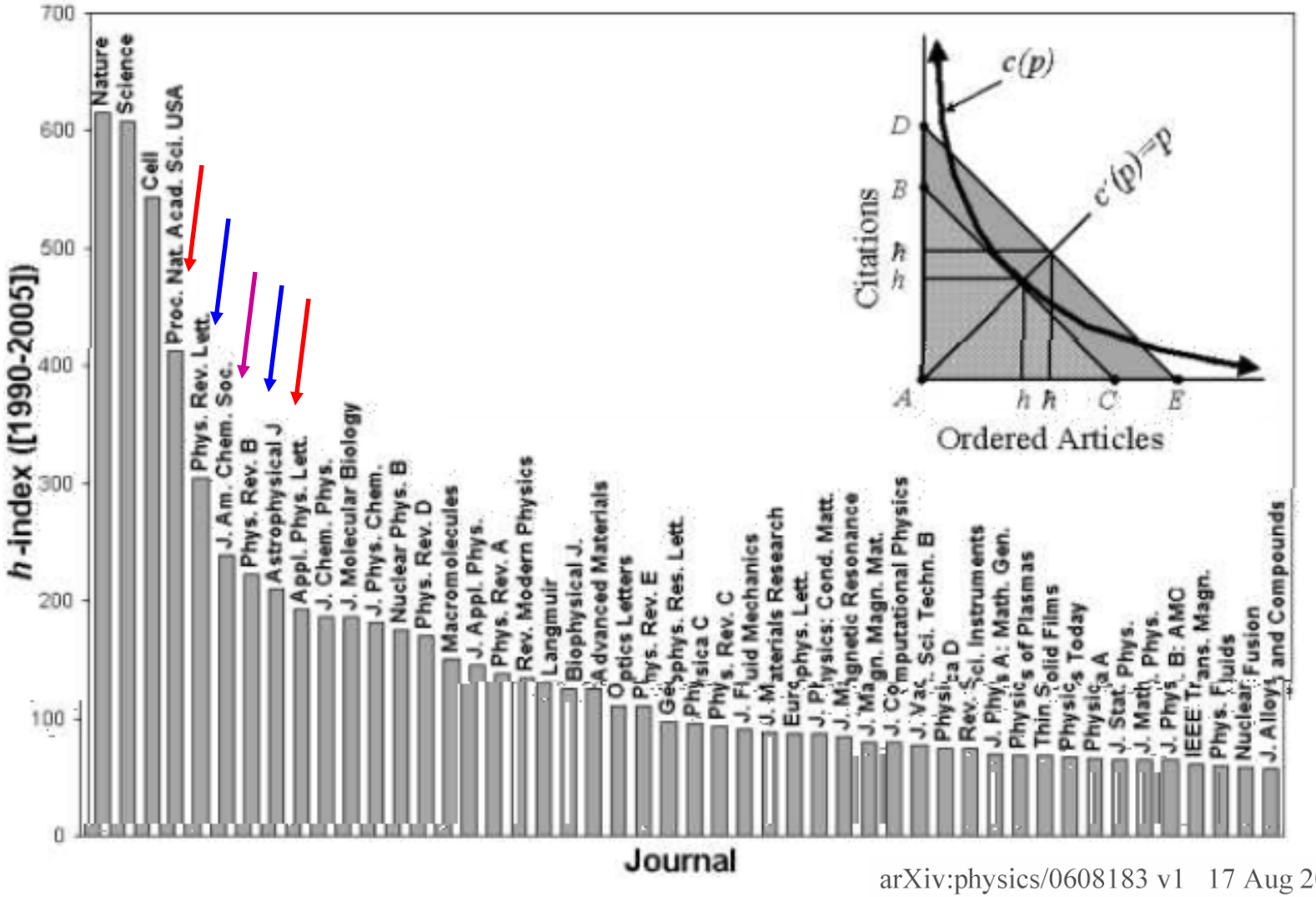
S.No	INST.	2001	2002	2003	2004	2005	All 5 years
1	IISc	4.83	4.60	4.49	4.18	4.25	4.44
2	BARC	2.96	3.12	2.81	2.78	2.33	2.77
3	IIT BOM	1.94	1.89	1.82	2.06	2.01	1.95
4	IIT DEL	1.91	1.90	2.18	2.22	2.26	2.12
5	IIT KAN	1.76	1.86	1.88	2.00	1.93	1.90
6	IIT KGP	2.23	2.11	2.11	2.40	2.34	2.25
7	IIT MAD	1.59	1.54	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



arXiv:physics/0608183 v1 17 Aug 2006

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

Web of science accessed on 16 sep 2005

Braun, Glanzel and Schubert, 2005, *The Scientist* 19 (22) 8, 21 Nov 2005

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)