

# CSIR-IICB Research Productivity during 2001-2010: A Scientometric Analysis of Publications

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## ABSTRACT

*The present research is an attempt to describe the quantity and quality of research publications of CSIR-IICB, Kolkata during ten years period from 2001-2010. The population under study was of 1228 documents on media literacy published through 2011. The results were analyzed based on date of publication, type of document, authorship pattern, source of publications, subject areas, affiliations, country origin of foreign collaborators. Citation indicators formed the second phase of investigation in the present study. There was increasing trend from 2001 to 2005 and reported 33.90% increase but there was considerable amount of fluctuation during 2006 to 2010. In the year 2006 53.01% increase was reported over 2001. The analysis of data based on document type indicated that, out of the 1228 publications, 1041 were articles (84.77%), 59 were reviews (4.80%), and 43 were conference papers (3.50%). It was disclosed from the analysis that major focus area of research as highest research papers were on Leishmania with 223 (29.89%) publications, followed by Synthesis of New Chemical Entities with 109 (14.61%) and Cancer Research with 101 (8.22%). The data analyzed to identify foreign collaboration and found the largest number of papers were published in Journal of Neurochemistry 27 (2.20%) followed by Tetrahedron Letters with 26 (2.12%) and Molecular and Cellular Biochemistry with 20 (1.63%). The most cited articles from 2001 up to 2010 included 46 researches on the h-index. University of Calcutta was the top collaborator from the country followed by Jadavpur University and Chittaranjan National Cancer Institute.*

**KEYWORDS:** Scientometric analysis; Research Productivity;

## Introduction:

Evaluating the productivity of institutional research and developmental activities highlights the contribution of the institution and the individual scientists engaged in research [Kademani et al]. Number of research publications, national and international collaborations, impact factors of the preferred journals and the field where the researches are being done are the important indicators to study the overall growth of an institution.

Indian Institute of Chemical Biology (IICB)—a centre of excellence in basic and applied biomedical research, was established in the year 1935 as first non-official centre for biomedical research in India. It was taken over by Council of Scientific & Industrial Research (CSIR) in 1956. CSIR-IICB is engaged in research on chemistry in life and diseases of national as well as global interest. Presently, it comprises of seven R&D Divisions- ‘Infectious Diseases and Immunology’, ‘Molecular & Human Genetics’, ‘Drug Development, Diagnostics & Biotechnology’, ‘Chemistry’, ‘Structural Biology & Bioinformatics’, ‘Cell Biology & Physiology’ and ‘Cancer Biology & Inflammatory Disorder Division. During this period of study CSIR-IICB has developed technologies like **ASMON**- a herbal medicine for the treatment of Asthma, **PROSTALYN**- a herbal extract for the treatment of benign Prostate hyperplasia, diagnostic kit for  $\alpha$ -fetoprotein for detection of fetal abnormalities and diagnostic kit of Kala-azar. The Institute has been also developing technologies like

- A Microbial Contraceptive to Prevent HIV
- Gene Therapy for Mitochondrial Diseases
- Anti-Diabetic (type-2) drug candidate
- Visceral leishmaniasis detection kit
- Anti-Leishmanial drug candidates
- DNA Vaccine against Kala-Azar
- Anti-Cancer drug candidates
- Anti-Ulcer drug candidates
- Aflatoxin detection kit
- Immunomodulator
- ALL detection kit

The institute is continuously maintaining a strong base of partnership with industries of national and international repute during this period of study. The major partners are DNDi, France, Coir Board, Cochi, Merial SAS Lyn, France, Zephyr Biomedical, Goa, Albert David Ltd., Kolkata, Qualpro Diagnostics, Goa, Piramal Life Sciences Ltd., Mumbai, Santha Biotechnics Ltd., Hyderabad, Biotech Consortium (I) Ltd., New Delhi, Dey's Medical Storage (Mfg.) Ltd., Kolkata, Chembiotech Research Int. Pvt. Ltd., Kolkata, Angiogen Pharmaceuticals Pte. Ltd., Australia, East India Pharmaceutical Works Ltd., Chatterjee Management Services Pvt. Ltd., Kolkata, ArQule Inc., USA, Dabur Research Foundations, Harbochem, Glenmark Pharmaceuticals, Bharat Biotech. The Institute bagged the 2002 CSIR Technology Award in the area of biological sciences and FICCI Award 2001-2002 [Annual Reports 2000-2010].

On 31<sup>st</sup> May, 2001 there were 108 scientists at CSIR-IICB and reached to 71 on 31<sup>st</sup> March, 2010. There was a remarkable downfall in number of total scientists during this period and published 1228 documents in the form of scholarly output, produced 262 PhDs and filed 171 patents out of which 106 in abroad and 65 in India. Research Institutions have to translate their research findings into objects which can be profitably used or sold[Lee, 2003]. In order to face the challenge emanating from globalization the Institute of late has been gearing up in a direction to license products/process to industry. As a result of this endeavour some of the patents have been licensed out to industries during the period under study [Annual Reports 2000-2010].

### **Review of Literature:**

Scientific productivity of an academic or a research organization and individual researcher's performances have been measured through its research publications and evaluated the growth. The studies also evaluated the growth of the organization as a whole and how far the trend of research is matched with the international research focus. These studies are also useful to assess the user's requirement for literature and management of library.

Lee has applied various scientometric techniques to study the research performance of the Institute of Molecular and Cell Biology (IMCB) during 1987 - 1996. Kademani et al have studied the publications published by Bio-organic Division of Bhabha Atomic Research Centre

(BARC) during 1972-2002. A scientometric analysis of area-wise publications in the field of structural engineering has been done by Maheswaran and others based on the research publications of CSIR- Structural Engineering Research Centre (CSIR-SERC) during 2002-2006. Wadhwa and others analyzed the papers published by CSIR-National Physical Laboratory (CSIR-NPL) during the period 1981-1985 and 2001-2005 using quantitative and qualitative indicators like publications count, impact factor per paper, citation received, h-index and collaborations pattern. CSIR -Central Electro Chemical Research Institute (CSIR-CECRI) published 1282 research articles during the period 2000-2009 and has been studied by Jeyshankar and other examined growth of CSIR-CECRI's research output, degree of collaboration, co-authorship index, most productive authors and preferred journals for publishing the scholarly output. Sahu et al assessed the research output of CSIR-National Metallurgical Laboratory (CSIR-NML) for the period 2001-2010, examined citation pattern, most productive authors and collaboration countries.

Number of such studies had already been communicated on research productivity in different disciplines, various academic institutions and research organizations. Many researchers analyzed institutional productivity of CSIR and this study has been concentrated on IICB- one of the constituent laboratories of CSIR.

### **Objectives:**

The main objective of the study is to quantify the growth publication from CSIR-IICB and to make the quantitative assessment of the status of research by way of analyzing the following features of research output:

- i) Growth trend of research papers.
- ii) Authorship pattern and most productive authors
- iii) Highly preferred journals for research publications.
- iv) Document types preferred for publication.
- v) Highly preferred area of research attraction.
- vi) Status of collaboration in research papers.
- vii) Pattern cited references.

## **Research Methodology:**

Data on research output in terms of publications had been downloaded from Web of Science (WOS) and supplemented by the records printed in Annual Reports published by CSIR-IICB time to time. The data retrieved from the WOS was retained as Note pad files on computer and developed in to a database by importing the Note pad files through Fangorn utility into CDS-ISIS software of the UNESCO. The data collected retained in CDS-ISIS and Microsoft's Excel was used for further analyses and inferences drawn.

Data retained was analyzed to facilitate chronological analysis, author analysis, country of origin, contributing institutions, subject-wise classification and sources preferred for publication of papers, etc.

Subject category is one of the best indicators to understand and grasp instantly the thought content of the papers and to find out the growth of the subject field. By analyzing the categories assigned by the indexer or the author himself helped in knowing in which direction the knowledge grows. Title of the publications, author's keywords and sometimes abstract were also studied to find out the disease focus wherever possible and categorized accordingly. Subject experts were also consulted for that purpose.

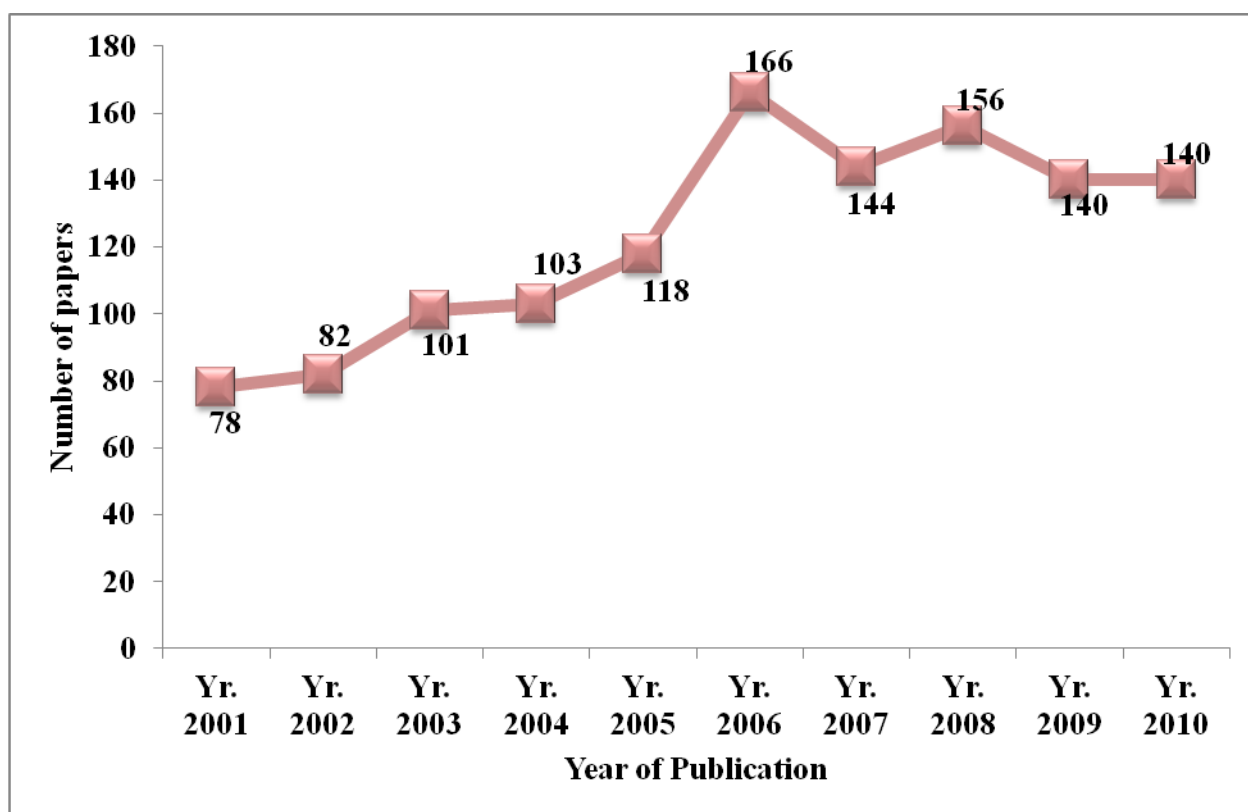
Citations received by 1228 publications published from CSIR-IICB during 2001-2010 are analyzed and a total of 16287 citations were retrieved up to December, 2011 from Web of Science.

## ANALYSIS AND RESULTS

### Annual distribution of publications

Research output of CSIR-IICB in the form of research publications illustrated in Figure 1 and table 1, a total of 1228 papers were published during 2001-2010. The average number of papers produced per year was 122.8 publications. The highest number of publications 166 (13.52%) were produced in 2006 with 40.68% increase over 2005. Increased trend in output was observed from 2001 to 2006 and decreasing trend noticed from 2007 to 2010 except 2008. In 2007 output was dropped by -13.25% against the year 2006 output.

**Table 1. Trend of research papers growth during 2001-2010**



Year	No. of papers	Percentage	Change over year in %
2001	78	6.35	0
2002	82	6.68	5.13
2003	101	8.22	23.17
2004	103	8.39	1.98
2005	118	9.61	14.56
2006	166	13.52	40.68
2007	144	11.73	-13.25
2008	156	12.70	8.33
2009	140	11.40	-10.26
2010	140	11.40	0.00

**Figure 1. Growth of research publications during 2001-2010**

### Publication types

Table 2 illustrates different preferences for publication modes were reported during the study period and there were seven modes preferred for publication of papers. Present study showed that research articles were 1014 (84.77%) followed by abstracts in conferences, workshops, etc., reviews with 59 (4.80%) and proceeding papers 43 (3.50%) and the rest are other categories.

**Table 2. Type-wise distribution of publications**

Form publication	Number of publications	Percentage
Articles	1041	84.77
Meeting Abstracts	63	5.13

Reviews	59	4.80
Proceedings Papers	43	3.50
Letters	11	0.90
Editorial Materials	6	0.49
Corrections	4	0.33
Biographical-Items	1	0.08



## Authorship pattern

In Table 3 authorship pattern in research papers was depicted, it shows that a large proportion of publications were multi-authored. Single authored papers were 20 (1.63%), followed by two authored 161 (13.11%), three authored papers were 219 (17.83%) and four authored accounted for 241 (19.63%), five authored for 183 (14.90%) and six authored were 132 (10.75%) publications. One to five numbers authored papers have the highest share that is 67.10% and 29.96% papers have 6 to 10 authors, 2.93% papers have 11 to 15 numbers of authors.

**Table 3 Authorship pattern in publications**

<b>No. of authors</b>	<b>No. of publications</b>	<b>Percentage</b>
1	20	1.63
2	161	13.11
3	219	17.83
4	241	19.63
5	183	14.90
6	132	10.75
7	100	8.14
8	72	5.86
9	40	3.26
10	24	1.95
11	18	1.47
12	10	0.81
13	3	0.24
14	0	0.00
15	5	0.41

## Preferred journals for publication

Table 4 provides distribution of articles in journals having published 10 or more papers during ten years period 2001-2010. It depicts that out of total 447 journals, the leading journals preferred by the scientists were; Journal of Neurochemistry with 27 (2.20%) followed by Glycoconjugate Journal with 18 (1.47%) and Journal of Organic Chemistry with 16 (1.30%) publications. On the whole average 2.75 papers published by a single journal.

**Table 4. Prime journals preferred for publications**

Name of journal	Impact Factor 2010	No. of publications	%
Antimicrobial Agents and Chemotherapy	5.672	11	0.90
Biochemical and Biophysical Research Communications	2.595	12	0.98
Biochemical Journal	5.06	11	0.90
Biochimica Et Biophysica Acta-General Subjects		15	1.22
Current Science	0.897	15	1.22
Free Radical Biology and Medicine	5.707	11	0.90
Glycoconjugate Journal	2.700	18	1.47
Indian Journal of Chemistry Section B	0.562	10	0.81
Infection and Immunity	4.098	15	1.22
Journal of Biological Chemistry	5.328	15	1.22
Journal of Neurochemistry	4.337	27	2.20
Journal of Organic Chemistry	4.002	16	1.30
Journal of Pineal Research	5.855	15	1.22
Molecular and Cellular Biochemistry	2.168	20	1.63
Molecular Vision	2.511	10	0.81
Nucleic Acids Research	-	11	0.90
Phytotherapy Research	1.878	14	1.14
Synthesis-Stuttgart	2.260	12	0.98
Tetrahedron	3.011	13	1.06
Tetrahedron Letters	2.618	26	2.12

## Subject categories of publications

Table 5 shows that the highest number of documents published on 'Leishmania' with 223 (18.16%) research papers. This table further showed that next preferred subject category was Synthesis of New Chemical Entities with 109 (8.88%) research papers followed by Cancer Research with 101 (8.22%), Neurosciences with 100 (8.14%), Biophysics and Structural Biology with 94 (7.65%), Drug Development and Discovery with 72 (5.86%), Genetics and Heredity with 54 (4.40%) and Biotechnology and Applied Microbiology with 51 (4.15%) was at eighth position.

**Table 5. Subject category undertaken for research during 2001-2010 in IICB.**

Subject Category	No. of research papers	%
Leishmania	223	18.16
Synthesis of New Chemical Entities	109	8.88
Cancer Research	101	8.22
Neurosciences	100	8.14
Biophysics and Structural Biology	94	7.65
Drug Development and Discovery	72	5.86
Genetics and Heredity	54	4.40
Biotechnology and Applied Microbiology	51	4.15
Cholera Research	49	3.99
Computational Biology and Bioinformatics	45	3.66
Reproductive Biology	44	3.58
Biochemistry and Molecular Biology	41	3.39
Endocrinology and Metabolic Disorders	40	3.26
Natural Products Chemistry	35	2.85
Gastrointestinal Disorders	30	2.44
Toxicology- Arsenic	27	2.20
Non-linear Dynamics	23	1.88
Biochemical Research Methods	22	1.79
Toxicology- Venom	16	1.30
Inflammatory and Immunological Disorders	13	1.05
Nuclear Medicine	12	0.98
Infectious Diseases- Malaria	7	0.57
Toxicology	6	0.49
Cardiovascular Disorders	4	0.33
Biological Research Methods	2	0.16
Veterinary Sciences	1	0.08
Infectious Diseases- Virology	1	0.08

Infectious Diseases- Tuberculosis	1	0.08
Infectious Diseases- Leprosy	1	0.08
Infectious Diseases- Encephalitis	1	0.08
Infectious Diseases- Bacteria	1	0.08
Crystallography	1	0.08
Biography	1	0.08

In Table 6 pattern of citation received by the research papers published from IICB during 2001-2010 was analyzed and a total of 16287 citations received by 1228 publications. An average of 13.26 citations was received by a single paper. Among the 1228 papers, 83 (6.76%) were cited 2 times. However, 156 publications (12.70%) were never cited. It was reported that 568 (46.25%) papers received 1 to 10 citations and 261 (21.25%) received 11 to 20 citations.

**Table 6. Citations received by the research papers published from IICB during 2001-2010 (16287)**

No. of citations	No. of papers	%	No. of citations	No. of papers	%
0	156	12.70	36	5	0.41
1	75	6.11	37	7	0.57
2	83	6.76	38	4	0.33
3	59	4.80	39	3	0.24
4	61	4.97	40	4	0.33
5	56	4.56	41	7	0.57
6	53	4.32	42	5	0.41
7	47	3.83	43	1	0.08
8	44	3.58	46	7	0.57
9	47	3.83	47	1	0.08
10	43	3.50	48	3	0.24
11	26	2.12	49	3	0.24
12	38	3.09	50	3	0.24
13	28	2.28	51	2	0.16
14	30	2.44	53	3	0.24
15	28	2.28	55	1	0.08
16	31	2.52	56	1	0.08
17	21	1.71	57	1	0.08
18	18	1.47	58	1	0.08
19	20	1.63	59	1	0.08
20	21	1.71	61	1	0.08
21	17	1.38	63	1	0.08
22	13	1.06	65	2	0.16
23	19	1.55	68	1	0.08
24	10	0.81	70	1	0.08

25	14	1.14	71	1	0.08
26	4	0.33	76	1	0.08
27	14	1.14	77	1	0.08
28	8	0.65	80	1	0.08
29	8	0.65	84	1	0.08
30	11	0.90	86	3	0.24
31	6	0.49	89	1	0.08
32	3	0.24	93	1	0.08
33	8	0.65	100	1	0.08
34	9	0.73	101<	9	0.73

**Table 7. Ranking of journals received high citations for CSIR-IICB research papers**

35	8	0.65
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Rank	Name of journal	Year	Citations
1	Current Science	2002	239
2	Current Science	2004	209
3	Mutation Research/Reviews In Mutation Research	2001	192
4	Genome Research	2003	178
5	British Journal of Pharmacology	2003	134
6	Journal of Biological Chemistry	2003	113
7	Journal of Biological Chemistry	2005	110
8	Mutation Research-Genetic Toxicology and Environmental Mutagenesis	2003	106
9	Nature Clinical Practice Neurology	2006	105
10	Cell Death and Differentiation	2004	100
11	Mutation Research-Reviews In Mutation Research	2002	93
12	Human Reproduction	2004	89
13	Biochemical Journal	2002	86
14	Human Genetics	2001	86
14	Journal of Immunology	2005	86
15	Current Medicinal Chemistry	2004	84
16	Nitric Oxide: Novel Actions, Deleterious Effects and Clinical Potential	2002	80
17	Medicinal Research Reviews	2007	77
18	Brain Research	2003	76
19	Journal of Biosciences	2002	71
20	Journal of Immunology	2001	70
21	Journal of Biological Chemistry	2004	68
22	Biochemical and Biophysical Research Communications	2001	65
22	Journal of Bacteriology	2003	65
23	Infection And Immunity	2002	63
24	Journal of Pineal Research	2004	61
25	Cancer Epidemiology Biomarkers Prevention	2004	59
26	Biochimica Et Biophysica Acta-Molecular Basis of Disease	2003	58
27	Phytotherapy Research	2001	57
28	Neurochemistry International	2004	56
29	Mutation Research-Genetic Toxicology and Environmental Mutagenesis	2002	55
30	Brain Research	2005	53
30	Molecular and Cellular Biochemistry	2003	53
30	Molecular Vision	2006	53
31	Science of the Total Environment	2001	51
31	World Journal of Microbiology Biotechnology	2002	51

#### **Ranking of journals received high citations**

Table 7 shows the journals published papers from CSIR-IICB during 2001-2010 and received 51 and more number of citations. There are 36 research papers that find place in this category. Papers published in 'Current Science' received highest citations i.e. 239 and 209 and this journal

secured first and second position. The ‘Mutation Research/Reviews in Mutation Research’ secured third position by receiving 192 citations. Out of total 16287 citations received by 1228 publications these 36 research papers received 3252 (19.97%) citations.

## Status of Citing CSIR-IICB Research papers

### Citing journals

Distribution of journal-wise citing papers for CSIR-IICB research papers is given in Table 8. Out of the 16287 citing papers 1556 (9.57%) published in top ranked 20 journals set. The average impact factor of these top ranked journals was 3.602 as per 2010 impact factor which can be considered as good citation report. Other details can be viewed from table 8.

**Table 8. Top ranked journals citing CSIR-IICB research papers during 2001-10 (2410)**

Rank	Name of journal	Impact Factor 2010	No. of papers	Percentage
1	PLOS One	4.411	235	2.22
2	Tetrahedron Letters	2.618	99	0.93
3	Journal of Pineal Research	5.855	98	0.92
4	Journal of Biological Chemistry	5.328	94	0.89
5	Tetrahedron	3.011	91	0.86
6	Journal of Ethnopharmacology	2.466	85	0.80
7	Infection and Immunity	4.098	71	0.67
8	Molecular Vision	2.511	63	0.59
9	Experimental Parasitology	1.869	57	0.54
10	Vaccine	3.572	56	0.53
11	Journal of Organic Chemistry	4.002	54	0.51
12	Journal of Bacteriology	3.726	53	0.50
13	Current Medicinal Chemistry	4.630	52	0.49
14	Organic Biomolecular Chemistry	3.451	51	0.48
15	Food and Chemical Toxicology	2.602	49	0.46
16	Journal of Agricultural and Food Chemistry	2.816	46	0.43
16	Journal of Physical Chemistry B	3.603	46	0.43
17	Bioorganic Medicinal Chemistry	2.978	45	0.42
18	European Journal of Medicinal Chemistry	3.193	44	0.42
19	Molecular Microbiology	4.819	42	0.40
19	Phytotherapy Research	1.878	42	0.40

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19	Toxicology and Applied Pharmacology	3.993	42	0.40
20	Parasitology Research	1.812	41	0.39

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## Citing organizations

Table 9 shows the top twenty citing organizations out of a total of 5765 organizations from which the papers published by citing CSIR-IICB research papers during 2001-10. It is evident from the table that top two positions were occupied by CSIR and third position was secured by the University of California, USA. The CSIR-IICB research papers were also had citations from Chinese institutions like Chinese Academy of Sciences.

**Table 9. Top ranked citing organizations for CSIR-IICB research papers (5765)**

Rank	Name of Institution	No. of papers	%
1	Council of Scientific Industrial Research, India	684	6.45
2	Indian Institute of Chemical Biology	283	2.67
3	University of California System	177	1.67
4	Chinese Academy of Sciences	155	1.46
5	Jadavpur University	126	1.19
6	Harvard University	112	1.06
7	Universidade De Sao Paulo	109	1.03
8	National Institutes of Health NIH, USA	105	0.99
9	Indian Institute of Technology	103	0.97
10	University of Calcutta	101	0.95
11	Fundacao Oswaldo Cruz	99	0.93
12	University of London	96	0.91
13	Consejo Superior De Investigaciones Cientificas Csic	87	0.82
14	Tehran University of Medical Sciences	77	0.73
15	Institut National De La Sante Et De La Recherche Medicale Inserm	76	0.72
16	Indian Association for the Cultivation Of Science	75	0.71
17	Banaras Hindu University	66	0.62
18	University of Texas Health Science Center, San Antonio	65	0.61
19	Indian Institute of Science, Bangalore	63	0.59
19	PGIMER, Chandigarh	63	0.59
19	Universidade Federal Do Rio De Janeiro	63	0.59
20	Zhejiang University	62	0.59

### Citing Languages

The data was analyzed to know the diversity of languages citing CSIR-IICB researches in the world and it was noticed that in addition to English, Chinese language was at top with 26 citations followed by Spanish with 18 citations, Portuguese with 17 citations and Polish with 8 citations. There were eighteen foreign languages that cited CSIR-IICB research papers as mentioned in table 10.

**Table 10. Language of citing papers of CSIR-IICB research papers**

Language	No. of papers	%
English	10502	99.03
Chinese	26	0.25
Spanish	18	0.17
Portuguese	17	0.16
Polish	8	0.08
French	7	0.07
German	7	0.07
Russian	6	0.06
Korean	4	0.04
Turkish	4	0.04
Japanese	3	0.03
Czech	2	0.02
Italian	1	0.01

### Citing countries

It was observed that India was at top in citing CSIR-IICB research papers with 2391 (22.95) citations followed by USA with 2148 (20.26%) citations, China with 1315 (12.40%) citations, Germany with 501 (4.72%) citations. It was encouraging that a good number of foreign researchers are citing CSIR-IICB research papers. There were 123 foreign countries from where researchers cited other than India and Top 20 countries have been mentioned in Table 11.

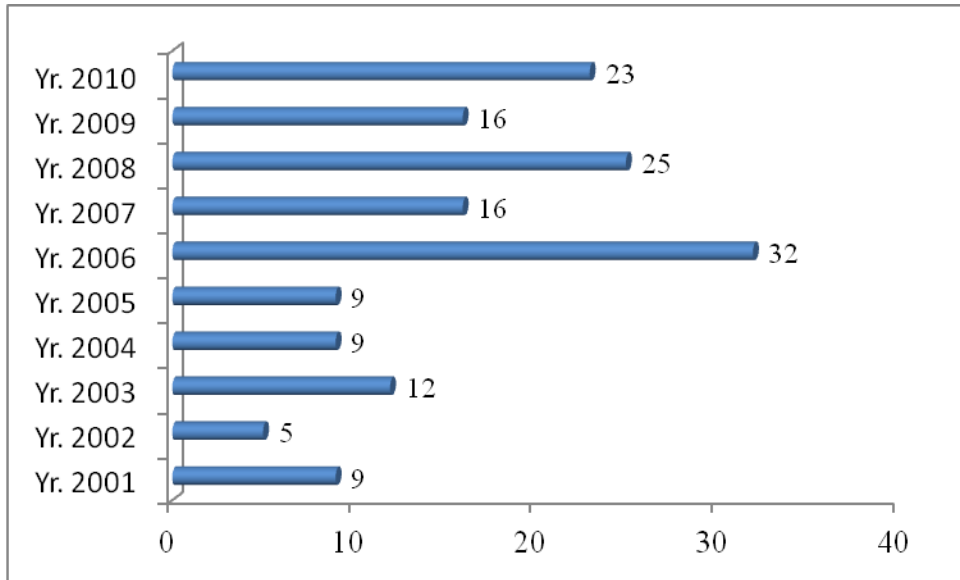
**Table 11. Top 20 ranked countries of citing papers**

Rank	Country	No. of papers	Percentage
1	India	2391	22.55
2	USA	2148	20.26

3	China	1315	12.40
4	Germany	501	4.72
5	Brazil	496	4.68
6	Spain	478	4.51
7	Japan	470	4.43
8	England	421	3.97
9	Italy	383	3.61
10	France	370	3.49
11	South Korea	339	3.20
12	Canada	336	3.17
13	Iran	235	2.22
14	Taiwan	230	2.17
15	Australia	174	1.64
16	Turkey	163	1.54
17	Poland	134	1.26
18	Belgium	124	1.17
18	Netherlands	124	1.17
19	Switzerland	117	1.10
20	Russia	116	1.09
20	Scotland	116	1.09

### **Distribution of CSIR-IICB publications with nil citation**

Research papers remained with nil citation depicted in Figure 2. A total of 156 (12.70%) publications got no citation during 2001-10. There were 32 publications published in the year 2006 that remained with nil citations followed by the year 2008 with 25 publications and 2010 with 23 publications.



**Figure 2. Year-wise distribution of publications with nil citation.**

### **Type of publications with nil citation**

There were 156 publications remained without citation published during 2001-10 from CSIR-IICB. Meeting abstracts were 64 in number followed by Articles 54, Proceeding papers 14, Reviews 11, Editorial material and Letters 5 each, Corrections 2 and 1 Bibliographic item.

**Table 12. Type of publications with nil citations**

<b>Type of publications</b>	<b>No. of publications</b>
Meeting Abstracts	64
Articles	54
Proceeding Papers	14
Review	11
Editorial Material	5
Letters	5
Corrections	2
Biographical Items	1

## Indian collaboration

Table 13 provides a view of CSIR-IICB collaborations with other Indian institutions for conducting research. It was evident from data on publications that scientists in the field of chemical biology are realizing the importance of collaborative research to deal with many problems as other scientific fields dealing. CSIR-IICB scientists collaborated with other Indian institutions, University of Calcutta topped with 61 (4.97%) papers followed by Jadavpur University with 57 (4.64%), Chittaranjan National Cancer Institute with 48 (3.91%) during ten years.

**Table 13. Major Indian collaborators in CSIR-IICB research during 2001-2010**

<b>Name of Institutions</b>	<b>No. of research papers</b>	<b>%</b>
University of Calcutta	61	4.97
Jadavpur University	57	4.64
Chittaranjan National Cancer Institute	48	3.91
Indian Association for the Cultivation of Science	32	2.61
Saha Institute of Nuclear Physics	29	2.36
Indian Statistical Institute	27	2.20
Medical College and Hospital	22	1.79
Bose Institute	21	1.71
Visva Bharati University	20	1.63
PGIMER, Chandigarh	17	1.38
Banaras Hindu University	15	1.22
Natl Inst Cholera Enter Dis	15	1.22
Vivekananda Inst Med Sci	15	1.22
Sch Trop Med	14	1.14
W Bank Hosp	13	1.06
Presidency Coll	11	0.90
Bangur Inst Neurol	10	0.81
Kothari Med Ctr	10	0.81

### Foreign collaborating institutions

Table 14 provides a view of CSIR-IICB's international collaboration in chemical biology research. Highest collaborations were reported with University of Texas Health Science Center San Antonio in 16 research papers followed by University of Reading with 12 papers, National Institutes of Health (NIH), USA and Free University of Berlin with 7 papers each.

**Table 14. Status of top foreign collaborating institutions in CSIR-IICB research during 2001-2010**

<b>Name of Institution</b>	<b>No. of research papers</b>
University of Texas Health Science Center, San Antonio	16
University of Reading	12
National Institutes of Health(NIH), USA	7
Free University of Berlin	7
University of Texas Medical Branch, Galveston	6
Humboldt University of Berlin	6
University of Manchester	5
Showa Pharmaceut Univ	5
Johns Hopkins University	5
Helmholtz Association	5
Charite Medical University of Berlin	5

### Foreign collaborating countries

Table 15 provides an overview of major foreign countries collaboration with CSIR-IICB for research in chemical biology. Countries with six or more collaborations tabulated in the table

below. Highest collaboration was reported with USA in 91 (7.41%) research papers followed by Germany with 31 (2.52%), UK with 27 (2.20%) and Japan at fourth position with 23 (1.87%).

**Table 15. Major countries collaborated in CSIR-IICB research during 2001-2010**

Name of country	No. of research papers	%
USA	91	7.41
Germany	31	2.52
UK	27	2.20
Japan	23	1.87
Italy	12	0.98
Netherlands	8	0.65
Sweden	6	0.49

#### **Pattern of cited references in CSIR-IICB Papers**

Table 16 depicts the pattern of references cited in the research papers published from CSIR-IICB during 2001-2010 and a total of 47450 references cited by 1228 publications with an average of 38.64 references by a single paper. Among the 1228 papers, 275 (22.39%) papers cited 31 to 40 references, 256 (20.85%) paper cited references between 51 to 100 and 252 (20.52%) papers cited references 21 to 30. However, 68 papers (5.54%) had not referred any reference.

**Table 16. References cited in research publications of CSIR-IICB during 2001-2010**

Range of references	No. of articles	%
0	68	5.54
1-10	50	4.07
11-20	130	10.59
21-30	252	20.52



31-40	275	22.39
41-50	164	13.36
51-100	256	20.85
101-200	27	2.20
201-299	5	0.41
301-399	1	0.08

## Journals cited in CSIR-IICB research papers

Table 17 tabulated the highly-cited journals in CSIR-IICB research papers published from CSIR-IICB during 2001-2010. The Journal of Biological Chemistry was the highly cited with 1937 (4.074%) A total of 47450 research papers were cited by 1228 publications with an average of 38.64 references by a single paper. Among the 1228 papers, 275 (22.39%) papers cited 31 to 40 references, 256 (20.85%) paper cited references 51 to 100 and 252 (20.52%) papers were cited references 21 to 30. However, 68 papers (5.54%) had not referred any reference.

**Table 17 highly cited journals by CSIR-IICB research papers during 2001-10**

Name of Journal	No. of times cited	Percentage
Journal Biol Chem	1937	4.074
Pproceeding Natl Acad Sci-Biol	1038	2.183
Biochemistry-Us	707	1.487
Nature	649	1.365
Infect Immun	640	1.346
Science	632	1.329
Journal Immunol	627	1.319
Journal Org Chem	487	1.024
Tetrahedron Lett	478	1.005
Nucleic Acids Res	467	0.982
Cancer Res	448	0.942
Journal Am Chem Soc	435	0.915
Biochem J	397	0.835
Journal Mol Biol	369	0.776
Tetrahedron	347	0.730
Biochem Bioph Res Com	346	0.728
Cell	325	0.683
Method Enzymol	312	0.656
Journal Exp Med	274	0.576
Journal Med Chem	274	0.576
Mol Biochem Parasit	269	0.566
Anal Biochem	263	0.553
FEBS Lett	259	0.545
Journal Bacteriol	247	0.519
Eur J Biochem	244	0.513
Phytochemistry	234	0.492
Antimicrob Agents Ch	228	0.479
Journal Infect Dis	228	0.479
Journal Neurochem	221	0.465
Biochim Biophys Acta	220	0.463
EMBO Journal	213	0.448
Int Journal Cancer	207	0.435
Journal Clin Invest	201	0.423

## Conclusion:

A steady growth in number of publications has been observed during 2001 – 2006 which gradually decreased except the year 2008 may be due to less number of scientific personnel in the pay roll. Out of 1228 research publications a maximum of 1041 documents are published in the form of research articles and only 54 research articles have got no citation. It is observed that the maximum articles have been published in foreign journal indexed in SCI where the highest impact factor is 5.672 (impact factor according to 2010) and average impact factor is 3.602 (JCR, 2010). Leishmania is the major area of research which contributed 223 papers. The average citation, 13.26 is earned from the papers published mostly in foreign journals with good impact factor indicates the quality of CSIR-IICB research output. Moreover CSIR-IICB researchers published papers in collaboration with various institutions of national and international repute. Therefore, the research contribution of CSIR-IICB has global impact in the field of biomedical science.

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