

## India's International Collaboration in Biochemistry

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### Abstract

This paper is an attempt to analyse 16070 research publications indexed in the field of Biochemistry and Molecular Biology in the Web of Science Core Collection by researchers from India in collaboration with other during 1973 to 2022. During the epoch, India produced 71125 publications in Biochemistry and Molecular Biology out of which 16070 (22.60%) are in international collaboration. There were only 15 publications in 1973 which increased to 2002 in the year 2022. Council of Scientific and Industrial Research (CSIR) is the most contributing organization in producing the research publication in collaboration with international scholars. International Journal of Biological Macromolecules is the most preferred journal for publication. The United States, Saudi Arabia, Germany, and the United Kingdom is the most preferred country for collaboration by an Indian scholar.

**Keywords:** Biochemistry, Collaboration, Research evaluation, Scientometric

### Introduction

Collaborating with the International community in research is often considered as a benchmark for superior quality among researchers in academia. The main purpose of

international research collaboration to share the expertise with one lab to the other, and having common scientific interests. Research collaboration also produces new knowledge or findings which are not considered to be possible by individual efforts<sup>1</sup>. Therefore, collaboration in the applied sciences like Biochemistry, Biotechnology, and Molecularbiology becomes necessary. International research collaboration also increases the visibility of published research output across the globe and also helpful in enhancing the impact of research publication. It has also been seen that publications in collaboration with international research group receives more citations in comparison to domestic collaboration or single-authored publications. Pathak, Bhatt&Kumari(2022) (1) highlighted that Organization with minimal research facility tends to collaborate with comparatively richer laboratories or organizations in order to meet with high-cost research activities. Yao (2021) (2) suggested that to develop a relationship which is mutually beneficial for the collaboration research partners or organizations helps in an attempt to solve the greater global problems to develop the mutually beneficial relationship and helps in solving greater global problems. International collaboration among researchers can also generate a nourishing environment for

solving problems and inspiring ideas that would be difficult to produce in non-collaborative research activities. There are many aspects of determining research collaboration but collaboration identified through co-authorship has been studied extensively by bibliometric scholars.

Pathak, Bhatt & Kumari reported India's international collaboration in Biotechnology during 1945-2021 using Web of Science-indexed publications. Features of Chinese research collaboration by Chinese authors in the field of Biotechnology has been analysed by Zhao et al (2016) (3) for publications indexed in SCIE. Collaboration among ASEAN countries in research area of plant biotechnology has been investigated by Payumo & Sutton (2015) (4). Pathak & Kumari (2019) (5) carried out international collaboration in the field of Pharmaceutical Sciences on the basis of publications indexed in the Web of Science core Collection during 2014-2018. Garg et al (7), Basu and Kumar (8), Prakasana et al (9), Gupta and Dhanwan (10), and Raina et al (11) used publications metadata from the Web of Science in order to find out collaboration patterns of Indian science.

### Materials and Methods

Data for this study was retrieved from the Web of Science-core Collection Database was used as a data source for this study. The Advance search feature of the database was used to search the data using the Web of Science category filed and search string used are as under:

WC= "Biochemistry and Molecular Biology" and the publication year was restricted upto year 2022. From the countries section India was filtered and document types Retraction, Retracted publication, withdrawn publication, and Correction were not considered for further analysis. All the data were exported into plain text file and was imported into MS-Excel for further analysis. This resulted into 33226 publications, Collaboration was determined through co-authorship data using affiliation information available in the Web of Science database. Further analysis, the publications which have India

and any other countries in the address were selected exclusively.

### Results and Discussion

In the year 1973, there were 15 publications in international collaboration by Indian researchers in the field of Biochemistry and molecular biology. and there were only 193 publications in collaboration with other countries /territories upto the year 1980. In the next decade's i.e., 1981-1990 notable increase in the number of publications in international collaboration by Indian researchers were seen with 549 publications. During 1991-2000 period 1059 research items appeared from India. During 2001-2010 publications in international collaboration increased to 2615 i.e., 2.5 times from previous decades. In the last decades the highest numbers of publications in the biochemistry and molecular biology in association with foreign collaborators have been produced. 72.52% of total publications in international collaboration appeared during 2011-2022 which indicates that there has been a significant increase in the growth of a number of publications in international collaboration in the field of Biochemistry. Figure 1 highlights the yearwise growth of publications in the field of biochemistry from India in collaboration with international scholars.

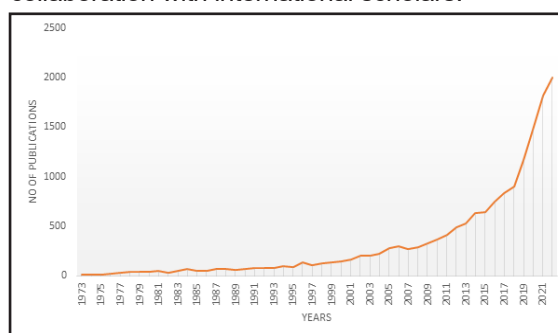


Fig. 1 — Yearwise Growth of Publication in International Collaboration

Table 1: The most prolific journals with more than 200 publications

Publication Titles	Record Count
International Journal of Biological Macromolecules	894

Molecules	852
International Journal of Molecular Sciences	586
Journal of Biomolecular Structure Dynamics	527
Journal of Biological Chemistry	410
Faseb Journal	405
Phytochemistry	404
Biochemical and Biophysical Research Communications	269
Bioorganic Medicinal Chemistry	261
Nucleic Acids Research	248
Applied Biochemistry and Biotechnology	242
Journal of Photochemistry and Photobiology B Biology	230
Process Biochemistry	210

These 16070 publications in international collaboration from India appeared in e 523 source titles or journals There are 31 number of journals/source titles which published 100 or more research items by Indian authors in collaboration with International counterparts and contributes 7961 of 16070 publications and published ~50 % of the total publications. Journals/ source titles publishing more than 100 publications has been listed in the (Table1).International Journal of Biological Macromolecules is the most prolific journals with 894 publications, followed by Molecules with 852 publications, International Journal of Molecular Sciences with 586 publications, Journal of Biomolecular Structure Dynamics with 527 publications and Journal of Biological Chemistry with 410 publications are the top 5 journals. There

Table 2 — The most productive organizations

Organizations	No. of Publications
Council of Scientific Industrial Research CSIR India	1760
Indian Institute of Technology System IIT System	1105

Department of Biotechnology DBT India	807
Indian Institute of Science IISC Bangalore	715
Department of Science Technology India	501
Indian Council of Agricultural Research ICAR	457
University of Delhi	435
Aligarh Muslim University	425
Tata Institute of Fundamental Research TIFR	390
Jamia Millia Islamia	340
Jawaharlal Nehru University New Delhi	335
Indian Council of Medical Research ICMR	315
Banaras Hindu University BHU	305

are 128 source titles which published only one research items.

Analysis of the most prolific organization publishing the research items in international collaboration it was found that the Council of Scientific and Industrial Research (CSIR)India is the most productive organizations with 1760 publications followed by the Indian Institute of Technology system with 1105 publications. Department of Biotechnology, DBT India with 807 publications, Indian Institute of Science Bangalore with 715 publications, Department of Science & Technology with 501 publications and the Indian Council of Agricultural Research with 457 publications are the other most contributing organizations. King Saud University, Saudi Arabia is the most preferred organizations for collaboration with 779 publications followed by UDICE French Research Universities with 471 publications and the National Institute of Health (NIH) with 421 publications. There are more than 11000 national and international organizations contributing in the Biochemistry and Molecular Biology research. Table 2 highlights the most prolific organizations from India and a List of the five most preferred organizations have been shown in the (Table 3).

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Table 3 — The Most Preferred organizations for collaboration

Organizations	No. of Publications
King Saud University	779
Udice French Research Universities	471
University of California System	442
National Institutes Of Health Nih Usa	421
Centre National De La Recherche Scientifique CNRS	381

Analysis of Document types suggest that these 16070 publications are categorized under 13 document types which consists of Article with 12703 publications followed by Review Article with 2196 items, Meeting Abstract 734 items, Note 189 items, Proceeding Paper 170 items, Editorial Material 167 items, Book Chapters 95 items, Letter 51 items, News Item having 4 items, Book Review 3 and Biographical-Item & Item About an Individual 1 each (Fig 2).

Indian researchers have published 5993 research items in collaborations with scientists and researchers from organizations based in United States of America (USA) followed by Saudi Arabia with 1846 publications, Germany with 1335 publications, the United Kingdom with 1071 publications and South Korea with 1036 publications. 70.20 % of the total publications i.e 11281 research items have been published in collaboration with these countries by Indian researchers. There are 18 countries which have only one publications in collaboration with India that includes Anguilla, Aruba, Cayman Islands, and Gabon. The top five countries in collaboration with India have published 70.20 % of the total publication in collaboration worldwide. (Table 4)

The top 10 highly cited Publications have been shown in the (Table 5). There are six publications which have received more than 1000 cita-

tions. The publication entitled Protein and ligand preparation: parameters, protocols, and influence on virtual screening enrichments by Sastry et al in Journal of computer aided -Molecular Design is the most highly cited publications with 2980 citations published in the year 2013 followed by a publication entitled Human Protein Reference Database-2009

Table 4 — Top Countries Preferred for Collaboration

Countries	Publications
USA	5993
Saudi Arabia	1846
Germany	1335
England	1071
South Korea	1036
Japan	990
Peoples R China	879
France	794
Australia	712
Canada	625
Italy	606

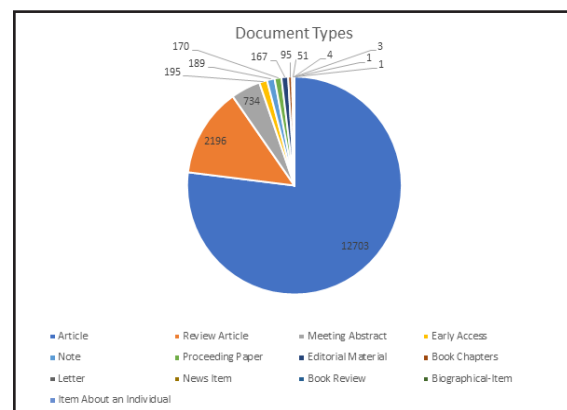


Fig. 2 — Types of Documents Published in International Collaboration

Table 5 — Top 10 Highly Cited Publications			
Citations	Authors	Title	Reference
2980	Sastry et al	Protein and ligand preparation: parameters, protocols, and influence on virtual screening enrichments	Journal of Computer-Aided Molecular Design,2013, 27 ,221-234 <a href="http://dx.doi.org/10.1007/s10822-013-9644-8">http://dx.doi.org/10.1007/s10822-013-9644-8</a>
2371	Prasad et al	Human Protein Reference Database-2009 update	Nucleic Acids Research,2009, 37 ,D767-D772 <a href="http://dx.doi.org/10.1093/nar/gkn892">http://dx.doi.org/10.1093/nar/gkn892</a>
1346	Albertson & Varma	Recent developments in ring opening polymerization of lactones for biomedical applications	Biomacromolecules,2003, 4 ,1466-1486 <a href="http://dx.doi.org/10.1021/bm034247a">http://dx.doi.org/10.1021/bm034247a</a>
1094	Shelley et al	Epik: a software program for pK (a) prediction and protonation state generation for drug-like molecules	Journal of Computer-Aided Molecular Design,2007, 21 ,681-691 <a href="http://dx.doi.org/10.1007/s10822-007-9133-z">http://dx.doi.org/10.1007/s10822-007-9133-z</a>
1090	Orchard et al	The MIntAct project-IntAct as a common curation platform for 11 molecular interaction databases	Nucleic Acids Research,2014, 42 ,D358-D363 <a href="http://dx.doi.org/10.1093/nar/gkt1115">http://dx.doi.org/10.1093/nar/gkt1115</a>
1062	Gupta & Huang	Mechanism of Salinity Tolerance in Plants: Physiological, Biochemical, and Molecular Characterization	International Journal of Genomics,2014, 2014 ,- <a href="http://dx.doi.org/10.1155/2014/701596">http://dx.doi.org/10.1155/2014/701596</a>
934	Karle & Balram	Structural Characteristics Of Alpha-Helical Peptide Molecules Containing AIB Residues	Biochemistry,1990, 29 ,6747-6756 <a href="http://dx.doi.org/10.1021/bi00481a001">http://dx.doi.org/10.1021/bi00481a001</a>
921	Hasanuzzaman et al	Physiological, Biochemical, and Molecular Mechanisms of Heat Stress Tolerance in Plants	International Journal of Molecular Sciences,2013, 14 ,9643-9684 <a href="http://dx.doi.org/10.3390/ijms14059643">http://dx.doi.org/10.3390/ijms14059643</a>
905	Franci et al	Silver Nanoparticles as Potential Antibacterial Agents	Molecules,2015, 20 ,8856-8874 <a href="http://dx.doi.org/10.3390/molecules20058856">http://dx.doi.org/10.3390/molecules20058856</a>
839	Vo et al	The Landscape of Circular RNA in Cancer	Cell,2019, 176 ,869-+ <a href="http://dx.doi.org/10.1016/j.cell.2018.12.021">http://dx.doi.org/10.1016/j.cell.2018.12.021</a>
921	Hasanuzzaman et al	Physiological, Biochemical, and Molecular Mechanisms of Heat Stress Tolerance in Plants	International Journal of Molecular Sciences,2013, 14 ,9643-9684 <a href="http://dx.doi.org/10.3390/ijms14059643">http://dx.doi.org/10.3390/ijms14059643</a>
905	Franci et al	Silver Nanoparticles as Potential Antibacterial Agents	Molecules,2015, 20 ,8856-8874 <a href="http://dx.doi.org/10.3390/molecules20058856">http://dx.doi.org/10.3390/molecules20058856</a>
839	Vo et al	The Landscape of Circular RNA in Cancer	Cell,2019, 176 ,869-+ <a href="http://dx.doi.org/10.1016/j.cell.2018.12.021">http://dx.doi.org/10.1016/j.cell.2018.12.021</a>

update by Prasad et al in the journal *Nucleic Acid Research* in the year 2009 with 2371 citations. Recent developments in ring opening polymerization of lactones for biomedical applications by Albertsson & Varma in the journal *Biomacromolecules* published in the year 2003 with 1346 citations ranks third among highly cited articles. Epik: a software program for pK (a) prediction and protonation state generation for drug-like molecules by Shelley et al in the year 2007 published in the journal of computer aided design with 1094 citations ranks fourth in the highly cited list.

### Conclusion

On the basis of data presented above it is opined that collaboration in biochemistry is increasing year by year and there has been significant growth in terms of publications count. Centrally funded organizations are the most prolific organization leading to publications in international collaboration, but state-funded universities are lagging behind in collaboration. This may be because state universities are often less equipped in comparison to centrally funded organizations and also unaware of publishing their research output in suitable journals. Publication in collaboration often appears in high-impact journals which are an important factor in deciding the impact of the publications as it receives more citations. This analysis is preliminary in nature, and more extensive study is required to find out the trend and pattern of research collaboration in Biochemistry and molecular biology.

### References

- 1 Pathak, M., Bhatt, A. ., & Prasanna, N. K. . (2022). India's International Collaboration in Biotechnology. *Current Trends in Biotechnology and Pharmacy*, 16(4), 511–517. <https://doi.org/10.5530/ctbp.2022.4.84>
- 2 Yao B. International Research Collaboration: Challenges and Opportunities. *Journal of Diagnostic Medical Sonography*. 2021;37(2):107-108. doi:10.1177/8756479320976130
- 3 Yong Zhao, Dong Li, Mingjie Han, Chenying Li & Dongmei Li. Characteristics of research collaboration in biotechnology in China: evidence from publications indexed in the SCIE. *Scientometrics* (2016) 107:1373–1387 DOI 10.1007/s11192-016-1898-1
- 4 Payumo JG & Sutton TC, A bibliometric assessment of ASEAN collaboration in plant biotechnology, *Scientometrics* (2015) 103:1043–1059 3–1059 DOI 10.1007/s11192-015-1582-x
- 5 Pathak Manoahr & Kumari NK Prasanna, India's International Collaboration in Pharmaceutical Research
- 6 *Journal of Scientific & Industrial Research*, 2019,78 ,738-741.
- 7 Garg K C, Kumar Suresh & Bebi, Collaboration Patterns of Indian Scientists in Organic Chemistry, *Curr Sci*, 114(2018) 1174-1180
- 8 Basu A & Vinu Kumar B S, International collaboration in Indian scientific paper, *Scientometrics*, 48 (2000) 381-402
- 9 Prakasan E R, Mohan Lalit, Girap Priya, Ganesh Surwase, Kademani B S & K Bhanumurthy, Scientometric facts on international collaborative Indian publications, *Curr Sci*, 106 (2014) 166-169
- 10 Gupta B M, Munshi U M & Mishra P K, S&T collaboration of India with other South Asian countries, *Curr Sci*, 83 (2002) 1201-1209
- 11 Raina Dhruv, Gupta BM & Kandhari R, Collaboration in Indian physics: A case study of the macro and micro parametrization of sub-disciplines (1800–1950), *Scientometrics*, 33(1995) 295-314.