Growth of Research Output in Genetic Engineering: A Scientometric Study

C. Balasubramani
Librarian, Mohamed Sathak A J College of Engineering, Chennai-603 103.

S. Gopalakrishnan
Head - Resource Centre, National Institute of Fashion Technology, Chennai-600 113.

D. Gnanasekaran
Librarian, Anand Institute of Higher Technology, Chennai – 603 103.

Abstract

The authors aim, in this paper, to identify the growth of research output on Genetic Engineering. For this study, the data were downloaded from the multi discipline citation database 'Scopus' and there were 165984 records contributed worldwide over a period of 40 years from 1974-2013. Among them, 59877 (36.07%) publications were contributed by USA and it holds first place. India holds 8th place with 5354 (3.23%) publications. Bibliometric techniques such as year wise distribution, bibliographic form of the records, area and sub filed of research, source titles and research organisations were studied.

Keywords

Bibliometric Study; Growth and Research Output; Genetic Engineering
.

Electronic access

The journal is available at www.jalis.in



Journal of Advances in Library and Information Science
ISSN: 2277-2219 Vol. 3. No.3. 2014. Pp179-185

INTRODUCTION

Bibliometric analysis is employed by researchers to study the growth of literature in given field. Pritchard (1969) defined the term Bibliometric as the application of statistical and mathematical methods to books and other communication. The bibliometrics has emerged as a thrust area of research, incorporating different branches of human knowledge. There are famous Laws of Bibliometric i.e. Lotka's law (1926) of scientific productivity, Bradford's law (1934) of scattering and Zips law (1949) on frequency of words. But the Bibliometric studies started in late sixties.

The term 'Scientometric' was introduced and came into prominence with the founding of Journals named "Scientometrics" by Braun, originally published in Hungary and now in Amsterdam. According to Nalimove and Mulchentko, Scientometric as the applications of those Quantitative methods, which are dealing with the analysis of Science, viewed as an information process in 1969. "Scientometrics is the study of the Quantitative aspects of Science, as a discipline or economic activity. It is part of the Sociology and has application to Science Policy making. Scientometrics involves quantitative studies of scientific activities including, among others, publications and overlaps bibliometrics to some extent".

GENETIC ENGINEERING

Genetic engineering, important technologies now available to scientists, was crucial to the sequencing of the human genome, and has greatly increased the potential for developing new medicines. Genetic engineering is the process of removing a gene from one organism and putting it into another. Often, the removed genes are put into bacteria or yeast cells so that scientists can study the gene or the protein it produces more easily. Sometimes, genes are put into a plant or an animal. One of the first genetic engineering advances involved the hormone insulin. Diabetes, a medical condition that affects millions of people, prevents the body from producing enough insulin necessary for cells to properly absorb sugar

The term genetic engineering initially meant any of a wide range of techniques for the modification or manipulation of organisms through the processes of heredity and reproduction. As such, the term embraced both artificial selection and all the interventions of biomedical techniques, among them

artificial insemination, in vitro fertilization (e.g., "test-tube" babies), sperm banks, cloning, and gene manipulation. But the term now denotes the narrower field of recombinant DNA technology, or gene cloning, in which DNA molecules from two or more sources are combined either within cells or in vitro and are then inserted into host organisms in which they are able to propagate. Gene cloning is used to produce new genetic combinations that are of value to science, medicine, agriculture, or industry.

NEED FOR THE STUDY

Genetic Engineering is a fusion of two top most subjects of Medical and Engineering. In the recent medical world, Stem cell technology is advanced treatment for complicated diseases. This genetic research is the base for the stem cell treatment. Genetic Engineering gave us a remarkable improvement in food production. In this populated world, Medicine and food are very essential. So the literature study on the Genetic engineering is necessary one. Scientific alteration of the structure of genetic material in a living organism, involves the production and use of recombinant DNA and has been employed to create bacteria that synthesize insulin and other human proteins. The development and application of scientific methods, procedures, and technologies that permit direct manipulation of genetic material in order to alter the hereditary traits of a cell, organism, or population. Thus genetic engineering has been gaining momentum in Scientific Research.

OBJECTIVES

Main objectives of the study are

1. To examine the worldwide research production in genetic engineering during the period 1974-2013.
2. To identify the document type of the publications in genetic engineering.
3. To identify the organisations conducting the research in genetic engineering.
4. To compare and measure the growth rate of literature published during the period 1974-2013.
5. To identify and analyse the research contribution in the subject field of genetic engineering.
6. To identify the top source titles those carry the research productions in genetic engineering.

HYPOTHESIS

The following hypotheses are formulated for this study based on objectives.

- There are more literatures published worldwide on genetic engineering.
- Growth of publications in genetic engineering is comparatively higher in developed countries.
- The research productivity in genetic engineering is dominated by English language.
- Journals are major source of publications for genetic engineering.
- There exists no steady growth in publication production in genetic engineering research.

METHODOLOGY

For this study, the literature on genetic engineering downloaded from online multidiscipline database 'Scopus' which is an international indexing and abstracting database. The term 'genetic engineering' was used for retrieving literatures The collected data has been classified using Microsoft Excel for the purpose of analysis. Statistical tools such as frequency distribution, percentage analysis and Bibliometric techniques such as Relative Growth Rate (RGR) and Doubling time (dt) were used for the study. Analysis on yearwise distribution, subject coverage and organisations which contributed papers was covered.

DATA INTERPRETATION AND FINDINGS

1. Country wise Distribution of Research Productivity

There are 165984 contribution are available in Scopus on Genetic engineering research worldwide. The country wise production research output in Genetic engineering is shown in Table 1.

Table 1:Country wise Distribution of Research Productivity

S. No.	Country	No. of Records	%	Cum %	RoG
1	United States	59877	36.07	36.07	1.00
2	China	12747	7.68	43.75	0.21
3	United Kingdom	12053	7.26	51.02	0.20
4	Japan	11636	7.01	58.03	0.19
5	Germany	10643	6.41	64.44	0.18
6	France	7410	4.46	68.90	0.12

7	Canada	6355	3.83	72.73	0.11
8	India	5354	3.23	75.96	0.09
9	South Korea	4382	2.64	78.60	0.07
10	Italy	4286	2.58	81.18	0.07
11	Australia	3964	2.39	83.57	0.07
12	Netherlands	3357	2.02	85.59	0.06
13	Spain	3251	1.96	87.55	0.05
14	Switzerland	2892	1.74	89.29	0.05
15	Thailand	2234	1.35	90.64	0.04
16	Others	15543	9.36	100.00	0.42
	Total	165984	100		

It is seen from Table 1 that collaborative researches have been carried out in the area Genetic engineering beyond the territory. Among the literatures published worldwide in genetic engineering, 18,208 publications seem to be the joint contribution of two or more countries. United States of America holds the key position with 59877 (36.07%) of total publications which is followed by China and UK. India holds 8th place with 5354 (3.23%) publications.

.

2. Year wise Distribution of Publications

The year wise distributions of research publications contributed in Genetic Engineering is given in Table 2

Table 2: Year wise Distribution of Publications

S. No.	Year	No. of Records	%	Cum Records	Cum %
1	1974	69	0.04	69	0.04
2	1975	69	0.04	138	0.08
3	1976	145	0.09	283	0.17
4	1977	106	0.06	389	0.23
5	1978	81	0.05	470	0.28
6	1979	100	0.06	570	0.34
7	1980	136	0.08	706	0.43
8	1981	225	0.14	931	0.56
9	1982	1105	0.67	2036	1.23
10	1983	2482	1.50	4518	2.72
11	1984	3631	2.19	8149	4.91
12	1985	5030	3.03	13179	7.94
13	1986	5550	3.34	18729	11.28
14	1987	5253	3.16	23982	14.45
15	1988	5965	3.59	29947	18.04
16	1989	7874	4.74	37821	22.79
17	1990	8467	5.10	46288	27.89
18	1991	821	0.49	47109	28.38
19	1992	909	0.55	48018	28.93
20	1993	1039	0.63	49057	29.56
21	1994	1135	0.68	50192	30.24
22	1995	1124	0.68	51316	30.92
23	1996	2820	1.70	54136	32.62
24	1997	3205	1.93	57341	34.55
25	1998	3343	2.01	60684	36.56
26	1999	3645	2.20	64329	38.76
27	2000	3887	2.34	68216	41.10
28	2001	4953	2.98	73169	44.08
29	2002	5397	3.25	78566	47.33
30	2003	6835	4.12	85401	51.45
31	2004	6906	4.16	92307	55.61
32	2005	8062	4.86	100369	60.47
33	2006	9075	5.47	109444	65.94
34	2007	7890	4.75	117334	70.69
35	2008	7387	4.45	124721	75.14
36	2009	7719	4.65	132440	79.79
37	2010	7898	4.76	140338	84.55
38	2011	8249	4.97	148587	89.52
39	2012	8901	5.36	157488	94.88
40	2013	8496	5.12	165984	100
	Total	165984	100		

Average publications: 4149.460

The Table 2 shows that a total of 165984 research publications in genetic engineering over the period of 40 years from 1974 to 2013 were published with an average of 4149 articles per year.

3. Bibliographic Form

The publications in genetic engineering were contributed in different bibliographic forms such as article, review, proceedings, short survey, notes, book chapters, etc and the same is shown in Table 3.

Table 3: Bibliographic Type

S. No.	Bibliographic Form	No. of Records	%
1	Article	123239	74.25
2	Review	18329	11.04
3	Conference Paper	8944	5.39
4	Short Survey	3424	2.06
5	Note	3139	1.89
6	Book Chapter	1534	0.92
7	Editorial	1316	0.79
8	Letter	932	0.56
9	Book	334	0.20
10	Erratum	125	0.08
11	Article in Press	118	0.07
12	Conference Review	99	0.06
13	Report	16	0.01
14	Business Article	1	0.00
15	Undefined	4434	2.67
		165984	100.00

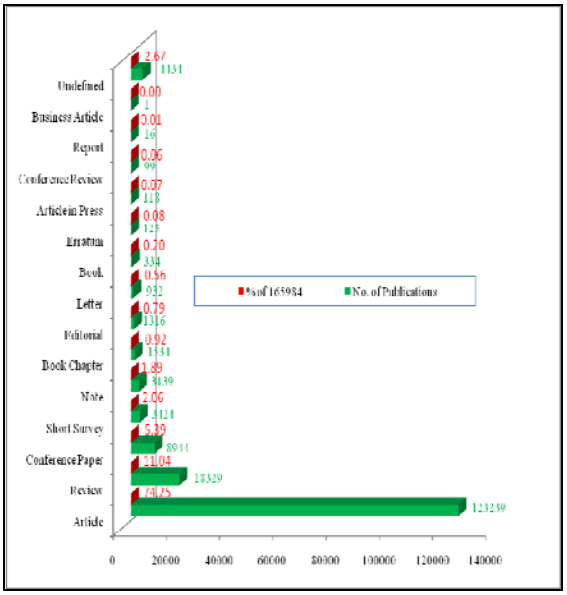


Fig.1 Bibliographic Form

Table 3 and Figure 1 show that maximum number of articles 123239 (74.25%) are published in journals. This is followed by reviews 18329 (11.04%) and proceedings paper 8944 (5.39%). It could be noted that only one publication is available as business article (0.00%). There are 4434 (2.67%) undefined type of publications.

4. Language wise Distribution of Publications

The research outputs on Genetic Engineering were contributed in 38 languages and the contribution in the top 20 languages is shown in Table 4.

Table 4: Language wise Distribution of Publications

S. No.	Language	No. of Records	%
1	English	157642	95.44
2	Chinese	2777	1.67
3	Russian	1074	0.65
4	French	845	0.51
5	German	807	0.49
6	Japanese	657	0.39
7	Spanish	375	0.23
8	Portuguese	179	0.11
9	Polish	133	0.08
10	Korean	127	0.08
11	Italian	102	0.06
12	Dutch	73	0.04
13	Turkish	58	0.03
14	Czech	47	0.03
15	Serbian	35	0.02
16	Others	1053	0.63
	Total	165984	100.00

It is noted from the Table 4 that 350 publications have been contributed in multiple languages. There are 158742 (95.44) publications were contributed in English and 2777 (1.67) were contributed in Chinese.

5. Relative Growth Rate and Doubling Time

Table 5 shows the Relative Growth Rate (RGR) and Doubling Time of the Indian publications genetic engineering

.

Table 5 :RGR and Doubling Time of Publications

S. No.	Year	No. of Records	Cum Records	RGR	dt
1	1974	69	69	4.23	0.16
2	1975	69	138	0.69	1.00
3	1976	145	283	0.72	0.96
4	1977	106	389	0.32	2.18
5	1978	81	470	0.19	3.66
6	1979	100	570	0.19	3.59
7	1980	136	706	0.21	3.24
8	1981	225	931	0.28	2.51
9	1982	1105	2036	0.78	0.89
10	1983	2482	4518	0.80	0.87
11	1984	3631	8149	0.59	1.17
12	1985	5030	13179	0.48	1.44
13	1986	5550	18729	0.35	1.97
14	1987	5253	23982	0.25	2.80
15	1988	5965	29947	0.22	3.12
16	1989	7874	37821	0.23	2.97
17	1990	8467	46288	0.20	3.43
18	1991	821	47109	0.02	39.42
19	1992	909	48018	0.02	36.26
20	1993	1039	49057	0.02	32.37
21	1994	1135	50192	0.02	30.30
22	1995	1124	51316	0.02	31.29
23	1996	2820	54136	0.05	12.95
24	1997	3205	57341	0.06	12.05
25	1998	3343	60684	0.06	12.23
26	1999	3645	64329	0.06	11.88
27	2000	3887	68216	0.06	11.81
28	2001	4953	73169	0.07	9.89
29	2002	5397	78566	0.07	9.74
30	2003	6835	85401	0.08	8.31
31	2004	6906	92307	0.08	8.91
32	2005	8062	100369	0.08	8.28
33	2006	9075	109444	0.09	8.01
34	2007	7890	117334	0.07	9.96
35	2008	7387	124721	0.06	11.35
36	2009	7719	132440	0.06	11.54
37	2010	7898	140338	0.06	11.96
38	2011	8249	148587	0.06	12.13
39	2012	8901	157488	0.06	11.91
40	2013	8496	165984	0.05	13.19
	Total	165984			

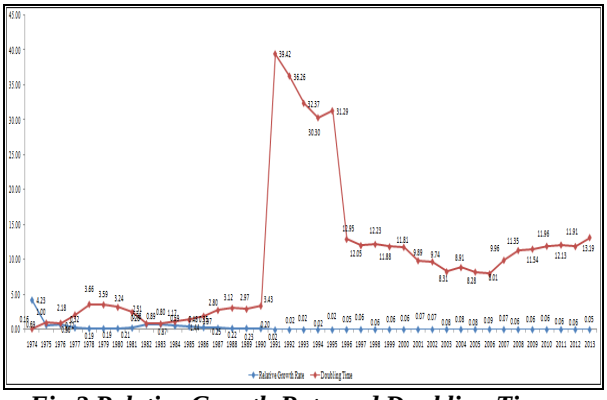


Fig.2 Relative Growth Rate and Doubling Time

Table 5 shows that there is no steady growth in the research production in Genetic Engineering during the study period.

6. Subject Area of Research on Genetic engineering

Research outputs on Genetic Engineering were contributed in 27 major sub-fields. Also the sub-fields of 1025 publications were unidentified. Among the 27 manor sub-fields, top 10 sub-fields are given in Table 6.

Table 6: Sub Field of Research Output on Genetic Engineering

S. No.	Subject Area	No. of Records	%
1	Biochemistry, Genetics and Molecular Biology	89756	54.08
2	Medicine	35805	21.57
3	Immunology and Microbiology	32972	19.86
4	Agricultural and Biological Sciences	29544	17.80
5	Chemical Engineering	12318	7.42
6	Multidisciplinary	9807	5.91
7	Engineering	9647	5.81
8	Environmental Science	8430	5.08
9	Pharmacology, Toxicology and Pharmaceutics	7805	4.70

10	Chemistry	7388	4.45
11	Others	27865	2.00

Table 6 gives the subfield wise distribution of research outputs, which shows that the publications were distributed into 27 subfields. Out of which 19 subfields bag more than 1000 publications each and 10 subfields occupied more than 7000 publications each. The subject biochemistry, genetics and molecular biology constituted the highest number of articles i.e. 89756 (54.08%). It seems that the main thrust on research on genetic engineering to be in these fields. It is followed by Medicine 35805 (21.57%) and immunology and microbiology 32972 (19.86%). There are 1025 publications are available in undefined subject area.

7. Source Titles and Genetic engineering Research Productivity

23 journals which have carried 10 and more publications are identified and the same is shown in Table 7.

Table 7: Source Title

S. No.	Source Title	No. of Records	%
1	Journal of Biological Chemistry	4776	2.88
2	Proceedings of the National Academy of Sciences of the United States of America	3771	2.27
3	Journal of Bacteriology	3164	1.91
4	Nature	2860	1.72
5	Gene	2797	1.69
6	Nucleic Acids Research	2464	1.48
7	Genetic Engineering and Biotechnology News	2305	1.39
8	Science	2020	1.22
9	Applied and Environmental Microbiology	1988	1.20
10	Theoretical and Applied Genetics	1703	1.03
11	Journal of Virology	1621	0.98
12	Applied Microbiology and Biotechnology	1274	0.77
13	Molecular and Cellular Biology	1226	0.74
14	Genetic Engineering News	1133	0.68
15	Biochemical and Biophysical Research Communications	1122	0.68
16	Plos One	1076	0.65
17	Biochemistry	1051	0.63
18	Nature Biotechnology	1018	0.61
19	Others	128615	77.49
	Total	165984	100.00

In general, the journals were the most preferred means of communications in Genetic Engineering. The Table 7 shows the list of 18 journals that carry more than 1000 contributions in the field. Among different sources which carry research outputs, 'Journal of Biological Chemistry' is ranked first with the 4776 records (2.88%) which is followed by 'Proceedings of the National Academy of Sciences of USA' with 3771 (2.27%) and 'Journal of Bacteriology' with 3164 (1.91%) publications.

8. Author and Genetic Engineering Research Productivity

The most productive authors based on their contribution in Genetic Engineering is identified and the same is shown in Table 8.

Table 8: Top 10 Authors based on Publications

S. No.	Author Name	No. of Records	%
1	Yu, L.	197	0.12
2	Visessanguan, W.	162	0.10
3	Potera, C.	153	0.09
4	Dutton, G.	152	0.09
5	Tuteja, N.	151	0.09
6	Jin, L.	148	0.09
7	Tang, K.	144	0.09
8	Benjakul, S.	142	0.09
9	Glaser, V.	139	0.08
10	Xie, Y.	129	0.08

Among the top 10 authors, Yu, L (0.12%), Visessangual, W (0.10%) and Potera,C (0.09%) hold top three positions.

9. Organisations and Genetic engineering Research

The top 20 organisations contributing research publications in Genetic Engineering were identified and the same is shown in Table 9.

Table 9: Contribution of Organisations on Genetic engineering Research

S. No.	Organisation	No. of Records	%
1	Fudan University	1658	1.00
2	Thailand National Center for Genetic Engineering and Biotechnology	1525	0.92
3	International Centre for Genetic Engineering and Biotechnology	1455	0.88
4	Harvard Medical School	1220	0.74
5	National Cancer Institute	1095	0.66

6	UC Berkeley	1090	0.66
7	University of Wisconsin Madison	1059	0.64
8	UC Davis	960	0.58
9	Massachusetts Institute of Technology	958	0.58
10	Kyoto University	950	0.57
11	University of Tokyo	900	0.54
12	National Institute for Genetic Engineering and Biotechnology Iran	879	0.53
13	University of Washington Seattle	863	0.52
14	University of California, San Francisco	848	0.51
15	Baylor College of Medicine	817	0.49
16	CNRS Centre National de la Recherche Scientifique	801	0.48
17	University of California, San Diego	792	0.48
18	[No Affiliation ID found]	770	0.46
19	Cornell University	766	0.46
20	Osaka University	750	0.45

Table 9 shows that Fudan University holds first place in contributing research productions in Genetic Engineering with 1658 (1.0%) of the total publications which is followed by Thailand National Center for Genetic Engineering and Biotechnology with 1525 (0.92%) and International Centre for Genetic Engineering and Biotechnology 1455 (0.88%) publications.

CONCLUSION

There are 165984 publications available in Scopus database worldwide in Genetic Engineering. United States of America holds the top position in producing research output with 59877 (36.07%) publications. India bags 5354 (3.23%) publications and placed in the 8th position. Relative Growth Rate and Doubling Times clearly show that there is no steady growth in the research on Genetic Engineering. The most popular subjects of research are Biochemistry, Genetics, Molecular Medicine, Immunology, Microbiology, Agricultural and Biological Sciences, In order to bring about more balance in future between different subfields of Genetic Engineering, more attention and funding needs to be focused. The lack of fund to the research is a major drawback to the researchers.

REFERENCES

1. Bradford, S.C (1934). Sources of information on specific subjects. *Engineering: An Illustrated Weekly*, 3550, 85-86.

2. Gupta B M et al. (2002) Modeling the growth of world social science litreature *Scientometrics.* 53(H):161-164

3. Bureau of Labour Statistics, India (2010). Report on Employment and Unemployment Survey (2009-10). Bureau of Labour Statistics, Govt. of India. Available at: http://labourbureau.nic.in/Final_Report_Emp_Unemp_2009_10.pdf

4. http://www.scopus.com

5. http://www.psrast.org/gefirstintro.htm.

6. https://en.wikipedia.org/wiki/Genetic_engineering.

7. Lotka, A. J. (1926). The frequency distribution of scientific productivity, *Journal of the Washington Academy of Science,* 16, 317-323.

8. Nair, A.J. (2008). Introduction to Biotechnology and Genetic Engineering. Firewall Media.

9. Pritchard, A (1969). Statistical bibliography or bibliometrics? *Journal of Documentation*, 24, 1348-349.

10. Sofer, William H. (1991). Introduction to genetic Engineering.

11. Wei, George. (2002). An introduction to Genetic Engineering, Life Science and Law. Singapore University Press.

12. Nichole, Desmond S T, (2008) An Introduction to Genetic Engineering. Cambridge University Press.