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Scientometric Analysis of Literature on Genetic Engineering (1989-2013)

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***Abstract* - This paper presents a Scientometric study of Genetic Engineering, the records published during the year 1989 to 2013 in the field of Genetic Engineering in the MEDLINE data which are covered in the Pubmed. On the whole, it is noticed that from 1989 onwards there is a gradual increase in research on Genetic Engineering except few years. It was found that 86.36% are journal articles, 3.21% are Comparative Study and 1.98% is English Abstract. 22 core journals grouped in zone 1 published 55829 articles accounting for one third of the total output. Similarly the second zone comprises of 179 journals and 4469 journals grouped in third zone. There are 201 journals covered in Zone-1 and Zone-2 have been identified as core journals in the field of Genetic Engineering. Core journals show that United States share 46.27% out of 201 journals followed by England with 26.87% in second position. Netherlands, Germany and Japan are in the third, fourth and fifth positions respectively. Indian efforts in Genetic Engineering research are greater in 11 years out of 25 years of study period. World output on Genetic Engineering grew almost uniform rate by year after year except few years and it was peak in 2012. In the case of Indian output the growth reaches in inconsistent manner and reaches its peak in 2013.**

I.INTRODUCTION

Scientometrics is the study dealing with the quantification of written communication, which helps, in the measurement of the published knowledge. It throws light on the pattern of growth of literature, inter-relationship among different branches of knowledge, productivity, authorship pattern, and degree of collaboration, pattern of collection building, and their use. Gradually Scientometrics/bibliometric studies are attaining the status of inter-disciplinary in nature[1]. Scientometrics/Bibliometric techniques are now being vigorously pursued and with the result, it has been found that one-fourth of all the articles published in Library and Information Science Periodicals are on Scientometrics/Bibliometrics and its related topics[2].

Scientometrics investigates quantitative aspects of science; it is the quantitative of the Science of Science, of Scientific Communication Studies and of Science Policy Studies. Scientometrics and Informetrics are bound through their mutual interest in scientific literature. Their statistical and mathematical orientation does not preclude analysis by qualitative methods[3].

In this paper an attempt has been made to identify the core journals in the field of Genetic Engineering and also to compare India's performance with the world's performance.

II. REVIEW OF LITERATURE

Bradford[4] described a scattering pattern of journals in the area of applied geophysics and lubrication. There are number of studies conducted on Bradford's Law. Many studies, applications and modifications have been practiced on this law over the period. Heine[5] noticed the different ranking conventions which exists in the relationship between 'journal productivities' and 'journal ranking by productivity' of Bradford's distributions. Ravichandra Rao[6] studied the applicability of what Bradford in his book on 'Documentation' derived, the law of scattering, based on algebraic explanation with the supposition that n1 = n2 = n. Feicheng and Rui[7] used the frequency rank analysis of Bradford's law in a research on mechanism and model of scattering distribution of scientific information. Bogaert, and other[8] showed how Bradford curves, i.e. cumulative rank frequency function used in informetrics can describe the fragment size distribution of percolation models.

There are number of studies on mapping and Bradford law in health sciences[9-20]. Schloman studied mapping the literature of allied health[21]. Kundra[22] studied the behaviour of Bradford's Law towards citation data on Indian Medical Journal. Ramesh Babu and Ramakrishnan[23] studied on Indian Contributions to the field of Hepatitis (1984-2003) and used Bradford law to identify the core journals. Patra and Prakash Chand[24] studied HIV/AIDS research in India. They used Bradford's law of scattering to identify core journals. Ramakrishnan and Thavamani[25] studied on literature of Hepatitis C. They identified 31 core Journals in the field of Hepatitis C with the help of Bradford's Law of Scattering.

III. GENETIC ENGINEERING

Genetic Engineering, also called genetic modification, is the direct manipulation of an organism's genome using biotechnology. New DNA may be inserted in the host genome by first isolating and copying the genetic material of interest using molecular cloning methods to generate a DNA sequence, or by synthesizing the DNA, and then

inserting this construct into the host organism. Genes may be removed, or "knocked out", using a nuclease. Gene targeting is a different technique that uses homologous recombination to change an endogenous gene, and can be used to delete a gene, remove exons, add a gene, or introduce point mutations.[26]

A huge number of articles, papers, reports and so on are being published on research work in Genetic Engineering. Since there is a continuous publication of information in this field, it is necessary to study quantitatively the output of literature by applying Scientometric techniques. It would benefit to identify core journals in the field of Genetic Engineering and also to compare India's performance with the world's performance.

IV. OBJECTIVES OF THE STUDY

The Objectives of this study are:

1. To identify the core journals in the field of Genetic Engineering.
2. To compare India's performance with the world's performance.

V. METHODOLOGY

The records published during the year 1989 to 2013 in the field of Genetic Engineering in the MEDLINE data which are covered in the Pubmed (www.pubmed.com) which is a free resource that is developed and maintained by the National Center for Biotechnology Information (NCBI), at the U.S. National Library of Medicine (NLM), located at the National Institutes of Health (NIH) was searched and bibliographic details like author, title, publication type, language, year; address of the contributors, country of publications, source etc. were collected.

The retrieved records were converted into FoxPro and loaded in SPSS for the purpose of analysis. The keyword 'Genetic Engineering' has been used for extracting the number of records available in the above said database. The data was analyzed to identify core journals in the field of Genetic Engineering and also to compare India's performance with the world's performance. In order to determine the core journals Bradford's law of scattering has been used to bring the core journals in the field of 'Genetic Engineering' and to compare India's performance with the world's performance, we have used the Activity Index, Activity Index characterizes the relative research effort of a country to a given field.

VI. LIMITATIONS

This study is confined to a period from 1989 to 2013 using MEDLINE data which covered in Pubmed only.

VII. ANALYSIS AND INTERPRETATION OF DATA

Data collected from the source database namely MEDLINE on the literary production of 'Genetic Engineering' for the period 1989-2013 has been analysed by using various bibliometric techniques as described.

The research productivity on 'Genetic Engineering' covered in the database is shown in Table 1. It is observed that total of 191089 records on 'Genetic Engineering' are covered in the MEDLINE data which covered in Pubmed for a period of twenty five years from 1989 to 2013.

The year-wise distribution of literature on 'Genetic Engineering' according to source database MEDLINE is shown in Table 1. It is found that the maximum number of records (12105) was published during 2012, followed by 11789 in 2011 and 11656 in 2010. On the whole, it is noticed that from 1989 onwards there is a gradual increase of Genetic Engineering research productivity every year except few years. (Fig.1)

TABLE 1 QUANTUM OF LITERATURE PUBLISHED IN GENETIC ENGINEERING BY YEAR WISE

S.No.	Year	Frequency	%	Cumulative %
1	1989	534	.3	.3
2	1990	1297	.7	1.0
3	1991	2480	1.3	2.3
4	1992	3171	1.7	3.9
5	1993	3854	2.0	5.9
6	1994	4420	2.3	8.2
7	1995	4916	2.6	10.8
8	1996	5158	2.7	13.5
9	1997	5668	3.0	16.5
10	1998	6877	3.6	20.1
11	1999	7574	4.0	24.0
12	2000	8966	4.7	28.7
13	2001	8889	4.7	33.4
14	2002	9115	4.8	38.2
15	2003	9535	5.0	43.1
16	2004	9918	5.2	48.3

17	2005	10185	5.3	53.7
18	2006	9901	5.2	58.9
19	2007	10339	5.4	64.3
20	2008	10835	5.7	69.9
21	2009	11050	5.8	75.7
22	2010	11656	6.1	81.8
23	2011	11789	6.2	88.0
24	2012	12105	6.3	94.3
25	2013	10857	5.7	100.0
Total		191089	100.0	

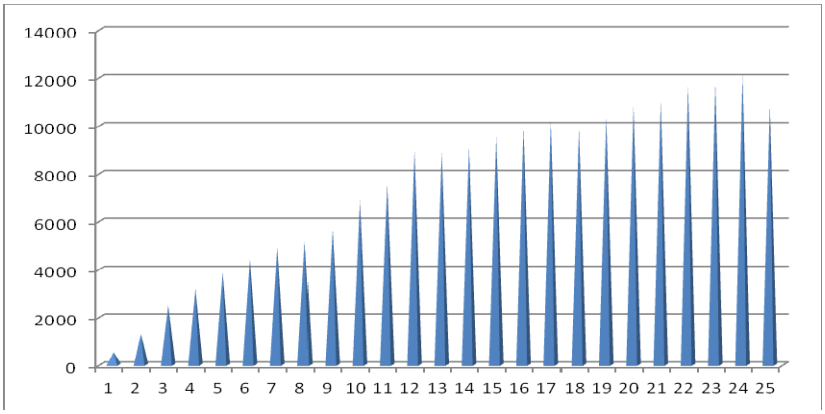

Fig. 1 Year wise Productivity of Genetic Engineering Research

Table 2 reveals the distribution of the 'Genetic Engineering' research output according to various publication types of MEDLINE. It was found that 86.36% are journal articles, 3.21% are Comparative Study and 1.98% is English Abstract. The literature published as other bibliographic forms such as Case Reports, In Vitro, Evaluation Studies, Comment, News, Editorial, Clinical Trial, Letter, Congresses etc. is 8.45%. (Fig.2)

TABLE 2 BIBLIOGRAPHIC FORMS OF GENETIC ENGINEERING RESEARCH

S.No.	Pub. Type	No. of records	%
1	Journal Article	165029	86.36
2	Comparative Study	6139	3.21
3	English Abstract	3781	1.98
4	Case Reports	2845	1.49
5	In Vitro	2532	1.33
6	Evaluation Studies	2050	1.07
7	Comment	2045	1.07
8	News	1652	0.86
9	Editorial	1222	0.64
10	Clinical Trial	1010	0.53
11	Letter	827	0.43
12	Congresses	667	0.35
13	Others	1290	0.68
		191089	100.00

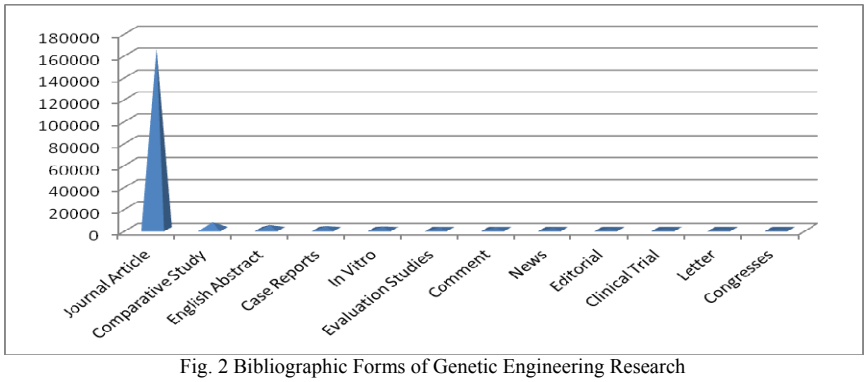

Fig. 2 Bibliographic Forms of Genetic Engineering Research

As per the Bradford Law, the journals which covered journal article are grouped into three zones producing similar number of articles. The distribution of journal by zone wise is given in the Table 3. It is seen from Table 3 that 22 core journals grouped in zone-1 published 55829 articles accounting for one third of the total output. Similarly the second zone comprises of 179 journals and 4469 journals grouped in third zone. (Fig.3)

TABLE 3 DISTRIBUTION BY ZONE OF CITED JOURNALS AND PAPERS IN GENETIC ENGINEERING

S.No.	Zone	No. of Journals		No. of Papers	
		No.	(%)	No.	(%)
1	Zone 1	22	0.47	55829	33.83
2	Zone 2	179	3.83	55215	33.46
3	Zone 3	4469	95.70	53985	32.71
	Total	4670	100	165029	100

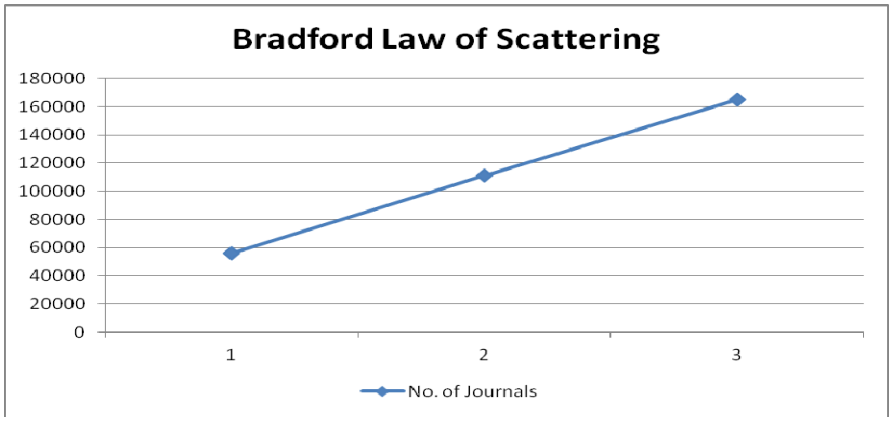

Fig. 3 Distribution of Journals by Zones

There are 201 journals contributed journal article for Zone 1 and Zone 2. Those journals are identified as core journals in the field of Genetic Engineering. Core journals along with the country of origin based on the research output on Genetic Engineering during the study period has been presented in the Table 4. There are 4670 journals contributed 165029 articles. The highly productive journals upto five ranks are as follows .

1. 'The Journal of biological chemistry' published from United States with 12783 contributions amounting to 7.75% of total contributions.
2. 'Biochemistry' published from United States with 6617 contributions amounting to 4.01%.
3. 'Proceedings of the National Academy of Sciences of the United States of America' published from United States with 3832 contributions amounting to 2.32%.
4. 'Journal of bacteriology' published from United States with 2825 contributions amounting to 1.71%.
5. 'Gene therapy' published from England with 2753 contributions amounting to 1.67%.

Out of the top five ranks United States is dominating in the first four ranks.

TABLE 4 CORE JOURNALS IN GENETIC ENGINEERING RESEARCH

S.No.	Name of the Journal	No. of Records	%	Country of origin
1.	The Journal of biological chemistry	12783	7.75	United States
2.	Biochemistry	6617	4.01	United States
3.	Proceedings of the National Academy of Sciences of the United States of America	3832	2.32	United States
4.	Journal of bacteriology	2825	1.71	United States
5.	Gene therapy	2753	1.67	England
6.	Journal of virology	2703	1.64	United States
7.	Journal of molecular biology	2414	1.46	England
8.	Biochemical and biophysical research communications	2293	1.39	United States
9.	PloS one	1954	1.18	United States
10.	Nucleic acids research	1800	1.09	England

S.No.	Name of the Journal	No. of Records	%	Country of origin
11.	FEBS letters	1599	0.97	Netherlands
12.	Biochimica et biophysica acta	1496	0.91	Netherlands
13.	Molecular therapy : the journal of the American Society of Gene Therapy	1412	0.86	United States
14.	Human gene therapy	1409	0.85	United States
15.	Methods in molecular biology (Clifton, N.J.)	1361	0.82	United States
16.	Molecular microbiology	1298	0.79	England
17.	Applied and environmental microbiology	1281	0.78	United States
18.	Applied microbiology and biotechnology	1250	0.76	Germany
19.	Molecular and cellular biology	1246	0.76	United States
20.	The Biochemical journal	1232	0.75	England
21.	Virology	1222	0.74	United States
22.	Blood	1049	0.64	United States
23.	Journal of immunology (Baltimore, Md. : 1950)	1030	0.62	United States
24.	Gene	957	0.58	Netherlands
25.	The EMBO journal	949	0.58	England
26.	European journal of biochemistry / FEBS	914	0.55	Germany
27.	Cancer gene therapy	913	0.55	England
28.	Journal of biotechnology	849	0.51	Netherlands
29.	Protein science : a publication of the Protein Society	837	0.51	United States
30.	Cancer research	784	0.48	United States
31.	Protein engineering	761	0.46	England
32.	Science (New York, N.Y.)	737	0.45	United States
33.	Archives of biochemistry and biophysics	734	0.44	United States
34.	Biotechnology and bioengineering	723	0.44	United States
35.	The Plant journal : for cell and molecular biology	664	0.40	England
36.	Microbiology (Reading, England)	646	0.39	England
37.	FEMS microbiology letters	616	0.37	England
38.	Oncogene	614	0.37	England
39.	Infection and immunity	601	0.36	United States
40.	Plant physiology	590	0.36	United States
41.	Biotechnology letters	588	0.36	Netherlands
42.	Nature biotechnology	580	0.35	United States
43.	The Journal of general virology	562	0.34	England
44.	Current opinion in biotechnology	560	0.34	England
45.	Biophysical journal	543	0.33	United States
46.	Genetics	537	0.33	United States
47.	Methods in enzymology	535	0.32	United States
48.	Annals of the New York Academy of Sciences	533	0.32	United States
49.	The journal of gene medicine	531	0.32	England
50.	Human genetics	520	0.32	Germany
51.	Nature	509	0.31	England
52.	Protein engineering, design & selection : PEDS	507	0.31	England
53.	Journal of biochemistry	505	0.31	England
54.	Antimicrobial agents and chemotherapy	491	0.30	United States
55.	Protein expression and purification	489	0.30	United States
56.	Molecular biology reports	488	0.30	Netherlands
57.	Journal of the American Chemical Society	475	0.29	United States
58.	Molecular pharmacology	469	0.28	United States
59.	Human molecular genetics	448	0.27	England
60.	Trends in biotechnology	437	0.26	England
61.	Metabolic engineering	426	0.26	Belgium
62.	Advances in experimental medicine and biology	425	0.26	United States
63.	Bioscience, biotechnology, and	420	0.25	Japan

S.No.	Name of the Journal	No. of Records	%	Country of origin
	biochemistry			
64.	The FEBS journal	413	0.25	England
65.	Current gene therapy	408	0.25	Netherlands
66.	Proteins	405	0.25	United States
67.	The Plant cell	396	0.24	United States
68.	The Journal of neuroscience : the official journal of the Society for	395	0.24	United States
69.	Molecular endocrinology (Baltimore, Md.)	379	0.23	United States
70.	Human mutation	370	0.22	United States
71.	Plant molecular biology	361	0.22	Netherlands
72.	Biotechnology progress	352	0.21	United States
73.	Cell	352	0.21	United States
74.	Applied biochemistry and biotechnology	346	0.21	United States
75.	The Journal of clinical investigation	344	0.21	United States
76.	Plant cell reports	336	0.20	Germany
77.	Vaccine	335	0.20	Netherlands
78.	Chemistry & biology	333	0.20	United States
79.	FASEB journal : official publication of the Federation of American Societies for	332	0.20	United States
80.	Molecular & general genetics : MGG	332	0.20	Germany
81.	Molecular biology of the cell	329	0.20	United States
82.	Virus research	326	0.20	Netherlands
83.	Bioinformatics (Oxford, England)	323	0.20	England
84.	Chembiochem : a European journal of chemical biology	313	0.19	Germany
85.	Expert opinion on biological therapy	311	0.19	England
86.	The Journal of cell biology	311	0.19	United States
87.	Journal of neurochemistry	309	0.19	England
88.	Molecular biology and evolution	308	0.19	United States
89.	Analytical biochemistry	305	0.18	United States
90.	Biomaterials	300	0.18	Netherlands
91.	Tissue antigens	299	0.18	England
92.	Journal of bioscience and bioengineering	297	0.18	Japan
93.	Biochemical Society transactions	295	0.18	England
94.	Journal of cell science	289	0.18	England
95.	Genes & development	284	0.17	United States
96.	BioTechniques	281	0.17	England
97.	Yeast (Chichester, England)	278	0.17	England
98.	Nihon rinsho. Japanese journal of clinical medicine	277	0.17	Japan
99.	Journal of controlled release : official journal of the Controlled Release	273	0.17	Netherlands
100.	Current opinion in molecular therapeutics	265	0.16	England
101.	Molecular cell	261	0.16	United States
102.	Clinical cancer research : an official journal of the American Association for	254	0.15	United States
103.	Molecular immunology	246	0.15	England
104.	Circulation	242	0.15	United States
105.	Archives of virology	240	0.15	Austria
106.	Bioresource technology	239	0.14	England
107.	Endocrinology	238	0.14	United States
108.	Tanpakushitsu kakusan koso. Protein, nucleic acid, enzyme	238	0.14	Japan
109.	BMC bioinformatics	237	0.14	England
110.	Circulation research	234	0.14	United States
111.	Molecular biotechnology	229	0.14	United States
112.	International journal of cancer. Journal international du cancer	227	0.14	United States
113.	Structure (London, England : 1993)	225	0.14	United States
114.	Biochimie	223	0.14	France
115.	RNA (New York, N.Y.)	222	0.13	United States

S.No.	Name of the Journal	No. of Records	%	Country of origin
116.	Biotechnology advances	215	0.13	England
117.	Angewandte Chemie (International ed. in English)	214	0.13	Germany
118.	Plant biotechnology journal	213	0.13	England
119.	Nature genetics	212	0.13	United States
120.	Molecular plant-microbe interactions : MPMI	209	0.13	United States
121.	Current microbiology	206	0.12	United States
122.	Biotechnology journal	203	0.12	Germany
123.	BMC biotechnology	203	0.12	England
124.	Acta crystallographica. Section D, Biological crystallography	202	0.12	United States
125.	Journal of industrial microbiology & biotechnology	202	0.12	England
126.	American journal of human genetics	201	0.12	United States
127.	Cancer letters	198	0.12	Ireland
128.	Anticancer research	195	0.12	Greece
129.	Genetic engineering	195	0.12	United States
130.	Genome research	195	0.12	United States
131.	Mutation research	194	0.12	Netherlands
132.	Plant & cell physiology	193	0.12	Japan
133.	BMC genomics	191	0.12	England
134.	World journal of gastroenterology : WJG	188	0.11	China
135.	Experimental cell research	187	0.11	United States
136.	Journal of experimental botany	184	0.11	England
137.	Nature medicine	183	0.11	United States
138.	Planta	183	0.11	Germany
139.	Thrombosis and haemostasis	183	0.11	Germany
140.	Molecules and cells	181	0.11	Korea (South)
141.	International journal of oncology	180	0.11	Greece
142.	The Journal of general physiology	180	0.11	United States
143.	Biomacromolecules	175	0.11	United States
144.	Current opinion in chemical biology	175	0.11	England
145.	Transgenic research	175	0.11	Netherlands
146.	Advanced drug delivery reviews	171	0.10	Netherlands
147.	Molecular genetics and metabolism	171	0.10	United States
148.	Methods (San Diego, Calif.)	170	0.10	United States
149.	Development (Cambridge, England)	169	0.10	England
150.	Cardiovascular research	168	0.10	England
151.	Plasmid	168	0.10	United States
152.	Investigative ophthalmology & visual science	165	0.10	United States
153.	Journal of medical virology	165	0.10	United States
154.	Oncology reports	165	0.10	Greece
155.	Diabetes	163	0.10	United States
156.	Molecular and cellular biochemistry	163	0.10	Netherlands
157.	The Journal of antimicrobial chemotherapy	163	0.10	England
158.	Journal of virological methods	161	0.10	Netherlands
159.	Virology journal	158	0.10	England
160.	Biotechnology and applied biochemistry	157	0.10	United States
161.	Nature structural biology	155	0.09	United States
162.	Journal of cellular biochemistry	153	0.09	United States
163.	Journal of theoretical biology	153	0.09	England
164.	Biological chemistry	152	0.09	Germany
165.	PLoS genetics	152	0.09	United States
166.	Bioconjugate chemistry	151	0.09	United States
167.	Methods in molecular medicine	151	0.09	United States
168.	The Journal of experimental medicine	151	0.09	United States
169.	Archives of microbiology	147	0.09	Germany
170.	International journal of molecular medicine	147	0.09	Greece
171.	European journal of immunology	145	0.09	Germany

S.No.	Name of the Journal	No. of Records	%	Country of origin
172.	Molecular genetics and genomics : MGG	145	0.09	Germany
173.	Molecular and biochemical parasitology	143	0.09	Netherlands
174.	Pharmaceutical research	143	0.09	United States
175.	Cellular and molecular life sciences : CMLS	141	0.09	Switzerland
176.	Cellular signalling	141	0.09	England
177.	Journal of medicinal chemistry	141	0.09	United States
178.	Journal of applied microbiology	139	0.08	England
179.	Current pharmaceutical design	138	0.08	Netherlands
180.	Current biology : CB	137	0.08	England
181.	The Journal of clinical endocrinology and metabolism	137	0.08	United States
182.	The Journal of pharmacology and experimental therapeutics	137	0.08	United States
183.	Neuron	136	0.08	United States
184.	DNA and cell biology	135	0.08	United States
185.	Molecular and cellular endocrinology	135	0.08	Ireland
186.	Current opinion in structural biology	134	0.08	England
187.	The Journal of physiology	134	0.08	England
188.	Chemical communications (Cambridge, England)	133	0.08	England
189.	FEMS yeast research	133	0.08	England
190.	Frontiers in bioscience : a journal and virtual library	133	0.08	United States
191.	Journal of molecular evolution	133	0.08	Germany
192.	Biochemical pharmacology	132	0.08	England
193.	Journal of molecular medicine (Berlin, Germany)	132	0.08	Germany
194.	Journal of immunological methods	131	0.08	Netherlands
195.	Microbial cell factories	131	0.08	England
196.	The Journal of infectious diseases	131	0.08	United States
197.	Nature methods	130	0.08	United States
198.	Peptides	130	0.08	United States
199.	AIDS research and human retroviruses	129	0.08	United States
200.	Arteriosclerosis, thrombosis, and vascular biology	129	0.08	United States
201.	Cancer immunology, immunotherapy : CII	129	0.08	Germany

The distribution of journals by country of origin in zones 1 and 2 are presented in the Tables 5, 6 and combined of Zone 1 & Zone 2 in Table 7 respectively. United States with the major contributions, share 63.64% of output in zone-1 followed by England with 22.73%. Netherlands and Germany share 9.0% and 4.55% respectively in the third and fourth position.

TABLE 5 DISTRIBUTION OF JOURNALS BY COUNTRY IN THE FIRST ZONE

S. No.	Country of origin	Total No. of Journals	%	Cumulative Total	Cumulative %
1	England	5	22.73	5	22.73
2	Germany	1	4.55	6	27.27
3	Netherlands	2	9.09	8	36.36
4	United States	14	63.64	22	100.00
Total		22	100.00		

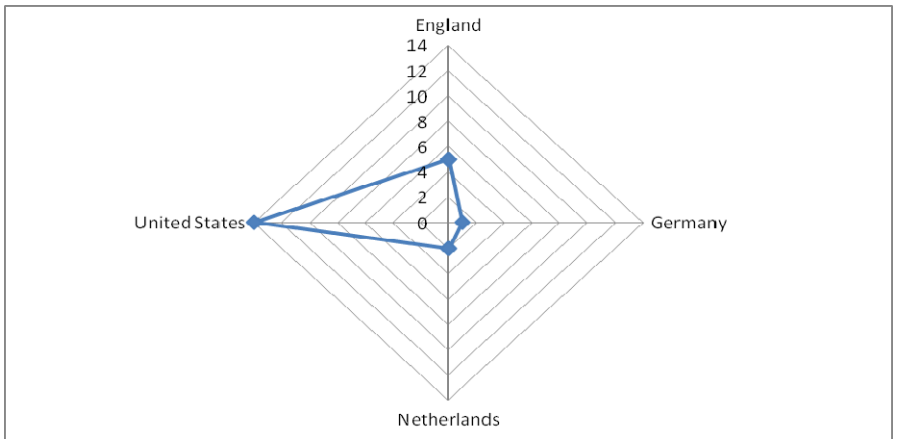

Fig. 4 Distribution of Journals by country in the First Zone

The distribution of journals by country of origin in zones 2 are presented in the Tables 6. In zone-2, United States share 44.13% out of 179 journals followed by England with 27.37% in second position. Netherlands, Germany and Japan are in the third, fourth and fifth positions respectively. (Fig.5)

TABLE 6 DISTRIBUTION OF JOURNALS BY COUNTRY IN THE SECOND ZONE

S. No.	Country of origin	Total No. of Journals	%	Cumulative Total	Cumulative %
1	Austria	1	0.56	1	0.56
2	Belgium	1	0.56	2	1.12
3	China	1	0.56	3	1.68
4	England	49	27.37	52	29.05
5	France	1	0.56	53	29.61
6	Germany	16	8.94	69	38.55
7	Greece	4	2.23	73	40.78
8	Ireland	2	1.12	75	41.90
9	Japan	5	2.79	80	44.69
10	Korea	1	0.56	81	45.25
11	Netherlands	18	10.06	99	55.31
12	Switzerland	1	0.56	100	55.87
13	United States	79	44.13	179	100.00
	Total	179	100.00		

Fig.5 Distribution of Journals by country in the Zone-2

The distribution of journals by country of origin in zone-1 and zone 2 combined are presented in the Tables 7. It also shows that United States share 46.27% out of 201 journals followed by England with 26.87% in second position. Netherlands, Germany and Japan are in the third, fourth and fifth positions respectively. (Fig.6)

It reveals that these countries are the core producers of literature on Genetic Engineering. The trend may be interpreted as the research on Genetic Engineering may be intensive in these countries. Probably MEDLINE database has covered more journals published from these countries.

TABLE 7 DISTRIBUTION OF JOURNALS BY COUNTRY IN THE COMBINED OF FIRST & SECOND ZONES

S. No.	Country of origin	Total No. of Journals	%	Cumulative Total	Cumulative %
1	Austria	1	0.50	1	0.50
2	Belgium	1	0.50	2	1.00
3	China	1	0.50	3	1.49
4	England	54	26.87	57	28.36
5	France	1	0.50	58	28.86
6	Germany	17	8.46	75	37.31
7	Greece	4	1.99	79	39.30
8	Ireland	2	1.00	81	40.30
9	Japan	5	2.49	86	42.79
10	Korea	1	0.50	87	43.28
11	Netherlands	20	9.95	107	53.23
12	Switzerland	1	0.50	108	53.73
13	United States	93	46.27	201	100.00
Total		201	100.00		

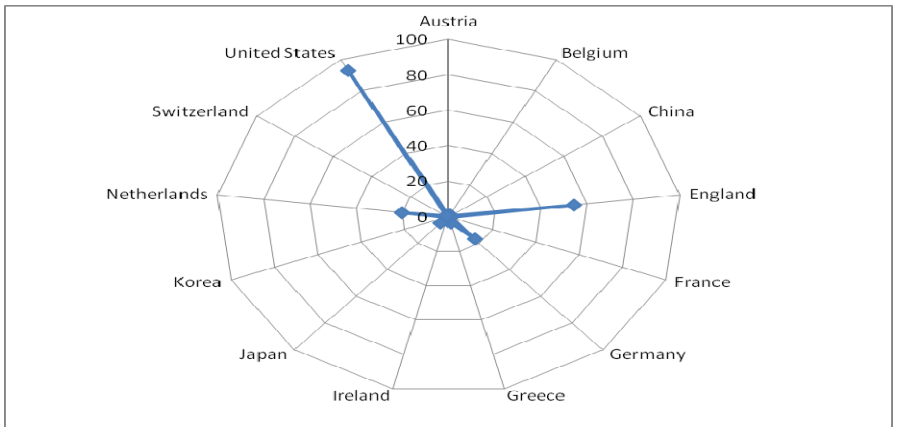

Fig. 6 Distribution of Journals by country in zone-1 and zone 2 combined

In order to compare India's research performance with the world's research output, Activity Index (AI) suggested by Price[35] and elaborated by elaborated by Karki and Garg[36] has been used. Activity Index (AI) characterized the relative research effort of the country to a given field. In Table 8, Activity Index for India has been calculated to analyse how India's research performance changes over different years. The data reveals that, Indian efforts in Genetic Engineering research is greater in 11 years out of 25 years of study, since the Activity Index is higher than 100, in those 11 years, which reflects higher activity of Genetic Engineering research than the World's average. In the years, where the Activity Index is less than 100, reflects lower activity of Genetic Engineering research than the world average. The Activity Index (AI) for India was peak in 2013 (181.11).

As seen in the graph (Figure 7) which indicates that the world output on Genetic Engineering grew almost uniform rate by year after year and it was peak in 2012. In the case of Indian output (Figure 8) the growth reaches in inconsistent manner and reaches its peak in 2013. In other words, the year 2012 has marked the highest quantum of research output in the world and 2013 in India.

TABLE 8 WORLD AND INDIAN OUTPUT IN GENETIC ENGINEERING DURING 1989-2013

S.No.	Year	World Output	Indian Output	Activity Index
1	1989	534	0	0.00
2	1990	1297	1	38.87
3	1991	2480	5	101.65
4	1992	3171	4	63.60
5	1993	3854	6	78.49

6	1994	4420	13	148.29
7	1995	4916	8	82.05
8	1996	5158	4	39.10
9	1997	5668	10	88.95
10	1998	6877	13	95.31
11	1999	7574	5	33.28
12	2000	8966	11	61.86
13	2001	8889	9	51.05
14	2002	9115	22	121.69
15	2003	9535	21	111.04
16	2004	9918	9	45.75
17	2005	10185	15	74.26
18	2006	9901	13	66.20
19	2007	10339	23	112.16
20	2008	10835	27	125.64
21	2009	11050	31	141.45
22	2010	11656	32	138.42
23	2011	11789	28	119.75
24	2012	12105	30	124.95
25	2013	10857	39	181.11
Total		191089	379 (0.20)*	100.00**

* Percentage of world output ** Average of Activity Index

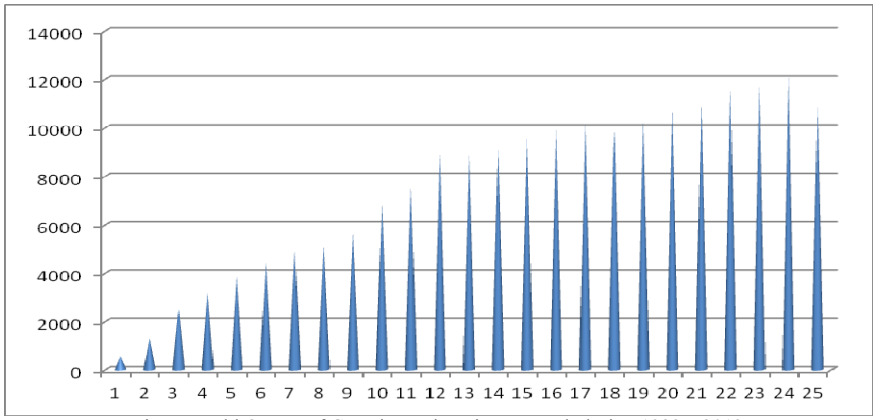

Fig. 7 World Output of Genetic Engineering research during 1989 – 2013

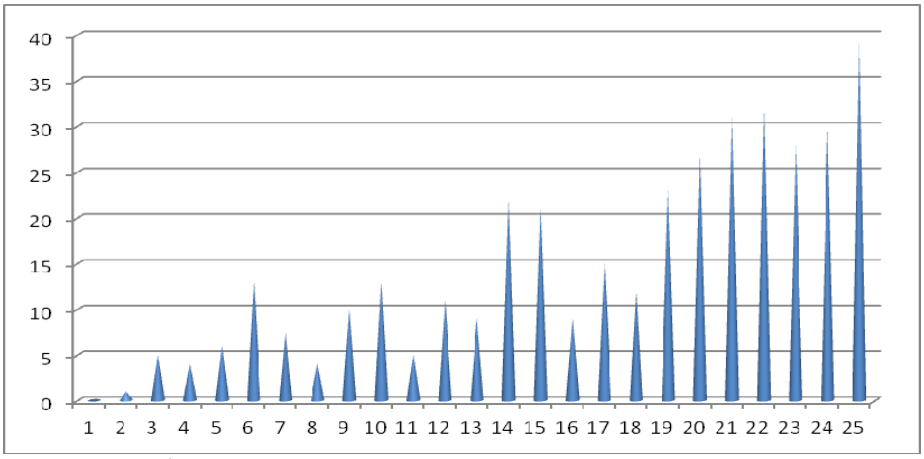

Fig. 8 Indian Output of Genetic Engineering research during 1989 – 2013

VIII. CONCLUSION

In the field of medicine, the results show that Genetic Engineering studies literature is growing year after year except few years. It also shows that maximum number of records covered by journal articles in MEDLINE in the field of Genetic Engineering. United States records on Genetic Engineering literature covered maximum numbers followed by England. Further the research productivity of Genetic Engineering confirms the implications of Bradford's Law of Scattering.

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