

# Trends in the Growth of Literature on Genetic Engineering (1989-2013)

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**Abstract** – This paper presents a scientometric analysis of the growth of literature output in the field of Genetic Engineering using MEDLINE data which are covered in the Pubmed. The literature covered in the database for the period 1989-2013 was considered. It covered the maximum of 191089 records during the study period from 1989 to 2013. It is found that the annual growth rate of literature in a particular field of knowledge is uniform and measure the rate of growth from year after year, the application of RGR and Dt are quite appropriate. The RGR has shown a decreasing trend and Doubling Time shown an increasing trend. It is also found that the annual growth rate of literature of journal articles in a particular field the RGR has shown a decreasing trend and Doubling Time shown an increasing trend. Genetic Engineering research indicates a different picture when the RGR and Dt were calculated by year-wise both in terms of number of papers and number of pages. It is found that the year wise calculation of RGR and Dt for Indian output has shown fluctuation trends throughout the study period.

**Keywords:** Fee Based, Library Services, University Libraries, Service charging.

## I. INTRODUCTION

This study was aimed to examine quantitatively the growth of literature in the field of ‘Genetic Engineering’ using MEDLINE data which are covered in the Pubmed. One of the most obvious features of science in recent years has been its rate of growth. Scientific growth has involved not only increase in manpower and finance<sup>1</sup>. The flood

of papers represents one aspect of the general growth of scientific communication.

Wooster (1970)<sup>2</sup> has estimated the number of journals that existed in the world at any one time, where as some estimates of the number of papers published annually at various times was done by Vickery (1968)<sup>3</sup> and Martyn (1973)<sup>4</sup>. Gottschalk and Desmond (1963)<sup>5</sup> have also estimated the number of scientific and technical journals existed in the World. Growth studies in other scientific areas included the work of Baker (1976)<sup>6</sup> in chemistry, Conard (1957)<sup>7</sup> in biology, May (1966)<sup>8</sup> and Lamb (1971)<sup>9</sup> in mathematics, Sengupta (1973) in microbiology<sup>10</sup>, physiology<sup>11</sup>, and biochemistry<sup>12</sup>.

## II. LITERATURE REVIEW

The growth of literature and its doubling time results in the field of Science and Technology<sup>13</sup> and Biological science literature in India during the period 1965-1989<sup>14</sup> has been analysed by Maheswarppa and Ningoji (1992 and 1993) with exponential, logistic and linear patterns of analysis and found that none of the patterns has been followed in the output. Aleixandre et al. (1995)<sup>15</sup> have conducted a study of the Spanish publications on AIDS, covering 2013 items, of which 1821 journal papers and 192 books. Their study confirmed exponential growth of publication since 1983 and the growth was similar to the trend observed in other countries. Karki, Garg, and Sharma (2000)<sup>16</sup> examined

the research productivity on Indian Organic Chemistry during the period 1971-1989 using *Chemical Abstracts*. They attempted to quantify the national contribution to world efforts and identified areas of relative strength and weakness, and also modeled the growth of Indian Organic Chemistry to world Organic Chemistry output as a whole, and in subfields, where the AI (Activity Index) for the world and India were similar. An attempt was made by Macias-Chapula (2000)<sup>17</sup> to identify the patterns of the growth in AIDS literature, as well as the types of documents published, authorship pattern, institutional affiliations of authors, and subject content. Rajendran, Ramesh Babu and Gopalakrishnan (2005)<sup>18</sup> analysed the global output of “fiber optics” research. Articles covered in the Ei-Tech Index database covering the period of 1999-2003 have been studied. Growth of literature by year wise, country wise, authorship pattern, bibliographic forms, ranking of core journals and nature of research have been analysed. Ramesh babu and Ramakrishnan (2007)<sup>19</sup> studied the growth of literature on “Hepatitis” and Ramakrishnan and Thavamani (2013)<sup>20</sup> in the field of “Hepatitis-C”

### 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.<sup>21</sup>

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 the growth rate of literature in the field of Genetic Engineering.

### IV. OBJECTIVES OF THE STUDY

- (1) To examine the year wise growth of Genetic Engineering literature output.
- (2) To analyse the Indian literature on “Genetic Engineering”.
- (3) To quantify the Research output in Journal Articles in terms of total pages.

### V. LIMITATION

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

### VI. 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](http://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 thus collected from the source database on the literary production of ‘Genetic Engineering’ for the period 1989 - 2013 has been analysed by using bibliometric indicators such as Relative Growth Rate (RGR) and Doubling Time (Dt).

### VII. ANALYSIS AND DISCUSSION

The literature has been classified in Table 1 according to year of publication. It is found that there is a gradual growth of literature in the subject of study by year after year. The year 2012 has marked a maximum of 6.3% out of total productivity in the study period. (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		

The analysis of data on the literary output in Genetic Engineering has been done with parameters such as Relative Growth Rate (RGR) and Doubling Time (Dt).

It is seen from Table 2 that there is decreasing trend in RGR by year wise. It is noticed that there is a decreasing trend in the year wise RGR in the field of Genetic Engineering research output. The RGR in the year 1990 is 1.23 which has been gradually decreased to 0.06 in 2013 (Figure 2).

Similarly the Dt has shown an increasing trend. The Dt for the year 1990 was 0.56 and enhanced gradually to 11.46 in 2013 (Figure 3).

It was thought appropriate to calculate and analyse the RGR and Dt for Indian output on Genetic Engineering research. Accordingly the data has been analysed and presented in Table 3. It is found from Table 3 that the year wise calculation of RGR and Dt for Indian output has shown fluctuation trends throughout the study period. The RGR has been decreased from 1991 (1.79) to 1993 (0.47).

TABLE II RGR AND DT FOR GENETIC ENGINEERING RESEARCH OUTPUT BY YEAR-WISE

S.No.	Year	Quantum of Output	Cumulative Total of Output	$W_1$	$W_2$	$1 - 2^{\overline{R}(aa^{-1} \text{ year}^{-1})}$ RGR	Dt(a)
1	1989	534	534		6.28		
2	1990	1297	1831	6.28	7.51	1.23	0.56
3	1991	2480	4311	7.51	8.37	0.86	0.81
4	1992	3171	7482	8.37	8.92	0.55	1.26
5	1993	3854	11336	8.92	9.34	0.42	1.67
6	1994	4420	15756	9.34	9.66	0.32	2.13
7	1995	4916	20672	9.66	9.94	0.28	2.51
8	1996	5158	25830	9.94	10.16	0.22	3.16
9	1997	5668	31498	10.16	10.36	0.20	3.51
10	1998	6877	38375	10.36	10.56	0.20	3.55
11	1999	7574	45949	10.56	10.74	0.18	3.95
12	2000	8966	54915	10.74	10.91	0.17	3.99
13	2001	8889	63804	10.91	11.06	0.15	4.51
14	2002	9115	72919	11.06	11.20	0.14	5.05
15	2003	9535	82454	11.2	11.32	0.12	5.78
16	2004	9918	92372	11.32	11.43	0.11	6.10
17	2005	10185	102557	11.43	11.54	0.11	6.41
18	2006	9901	112458	11.54	11.63	0.09	7.67
19	2007	10339	122797	11.63	11.72	0.09	7.85
20	2008	10835	133632	11.72	11.80	0.08	8.37
21	2009	11050	144682	11.8	11.88	0.08	8.42
22	2010	11656	156338	11.88	11.96	0.08	8.69
23	2011	11789	168127	11.96	12.03	0.07	9.56
24	2012	12105	180232	12.03	12.10	0.07	9.62
25	2013	10857	191089	12.1	12.16	0.06	11.46

In 1994 it has been enhanced to 0.60, and since then there is fluctuation up to 2013 (0.11) (Figure 4). There was nil record in the year 1989.

The Dt also fluctuated from year after year. The Dt increased from 0.39 in 1991 to 1.47 in 1993 and it has gone down to 1.16 in 1994. Since then, there is fluctuation by year after year (Figure 5).

TABLE III RGR AND DT FOR GENETIC ENGINEERING RESEARCH OUT PUT IN INDIA

S.No.	Year	Quantum of Output	Cumulative Total of Output	$W_1$	$W_2$	$1 - 2^{\overline{R}(aa^{-1} \text{ year}^{-1})}$ RGR	Dt(a)
1	1989	0	0				
2	1990	1	1		0.00	0.00	0.00
3	1991	5	6	0	1.79	1.79	0.39
4	1992	4	10	1.79	2.30	0.51	1.35
5	1993	6	16	2.3	2.77	0.47	1.47
6	1994	13	29	2.77	3.37	0.60	1.16
7	1995	8	37	3.37	3.61	0.24	2.88
8	1996	4	41	3.61	3.71	0.10	6.69
9	1997	10	51	3.71	3.93	0.22	3.12
10	1998	13	64	3.93	4.16	0.23	3.03
11	1999	5	69	4.16	4.23	0.07	9.35
12	2000	11	80	4.23	4.38	0.15	4.56
13	2001	9	89	4.38	4.49	0.11	6.38
14	2002	22	111	4.49	4.71	0.22	3.16
15	2003	21	132	4.71	4.88	0.17	4.01
16	2004	9	141	4.88	4.95	0.07	10.08
17	2005	15	156	4.95	5.05	0.10	6.94
18	2006	13	169	5.05	5.13	0.08	8.67
19	2007	23	192	5.13	5.26	0.13	5.44
20	2008	27	219	5.26	5.39	0.13	5.37
21	2009	31	250	5.39	5.52	0.13	5.27
22	2010	32	282	5.52	5.64	0.12	5.68
23	2011	28	310	5.64	5.74	0.10	7.18
24	2012	30	340	5.74	5.83	0.09	7.79
25	2013	39	379	5.83	5.94	0.11	6.44

It is seen from Table 4 that there is decreasing trend in RGR by year wise. It is noticed that there is a decreasing trend in the year wise RGR in the field of Genetic Engineering research output. The RGR in the year 1990 is 1.34 which has been gradually decreased to 0.06 in 2013 (Figure 6).

Similarly the Dt has shown an increasing trend. The Dt for the year 1990 was 0.52 and enhanced gradually to 10.85 in 2013 (Figure 7).

TABLE IV RGR AND DT FOR JOURNAL ARTICLES IN GENETIC ENGINEERING RESEARCH

S.No.	Year	Quantum of Output	Cumulative Total of Output	$W_1$	$W_2$	$1 - 2^{\overline{R}(aa^{-1} \text{ year}^{-1})}$ RGR	Dt(a)
1	1989	401	401		5.99		
2	1990	1124	1525	5.99	7.33	1.34	0.52
3	1991	2302	3827	7.33	8.25	0.92	0.75
4	1992	2896	6723	8.25	8.81	0.56	1.23
5	1993	3492	10215	8.81	9.23	0.42	1.64
6	1994	3981	14196	9.23	9.56	0.33	2.10
7	1995	4435	18631	9.56	9.83	0.27	2.54
8	1996	4781	23412	9.83	10.06	0.23	3.00
9	1997	5192	28604	10.06	10.26	0.20	3.44
10	1998	6282	34886	10.26	10.46	0.20	3.47
11	1999	6796	41682	10.46	10.64	0.18	3.90
12	2000	7252	48934	10.64	10.80	0.16	4.38
13	2001	8132	57066	10.8	10.95	0.15	4.56
14	2002	8038	65104	10.95	11.08	0.13	5.18
15	2003	8275	73379	11.08	11.20	0.12	5.62
16	2004	7643	81022	11.2	11.30	0.10	6.76
17	2005	8001	89023	11.3	11.40	0.10	7.17
18	2006	7923	96946	11.4	11.48	0.08	8.46
19	2007	8564	105510	11.48	11.57	0.09	8.01
20	2008	9186	114696	11.57	11.65	0.08	8.66
21	2009	9440	124136	11.65	11.73	0.08	8.76
22	2010	10019	134155	11.73	11.81	0.08	9.03
23	2011	10296	144451	11.81	11.88	0.07	9.80
24	2012	10770	155221	11.88	11.95	0.07	9.54
25	2013	9808	165029	11.95	12.01	0.06	10.85

The year wise calculation of RGR and Dt for the total pages in Genetic Engineering research has been presented in the Table 5. It is seen from the Table 5 that there is a decreasing trend in RGR by year after year. It was 1.36 in the year 1990 and since then it is gradually decreasing and in 2013 it was 0.06 except few years. (Figure 8).

Similarly Dt also shows an increasing trend. It was 0.51 in 1990 and increasing gradually to 11.44 for the year 2013 except few years. (Figure 9).

TABLE V RGR AND DT FOR TOTAL PAGES IN GENETIC ENGINEERING RESEARCH

S.No.	Year	Quantum of Output	Cumulative Total of Output	W <sub>1</sub>	W <sub>2</sub>	$1 - 2\bar{R}^{(pp^{-1} \text{ year}^{-1})}$ RGR	Dt(p)
1	1989	3830	3830		8.25		
2	1990	11028	14858	8.25	9.61	1.36	0.51
3	1991	19081	33939	9.61	10.43	0.82	0.84
4	1992	23458	57397	10.43	10.96	0.53	1.31
5	1993	31424	88821	10.96	11.39	0.43	1.60
6	1994	36066	124887	11.39	11.74	0.35	2.01
7	1995	41128	166015	11.74	12.02	0.28	2.48
8	1996	41619	207634	12.02	12.24	0.22	3.10
9	1997	44185	251819	12.24	12.44	0.20	3.53
10	1998	56608	308427	12.44	12.64	0.20	3.48
11	1999	62615	371042	12.64	12.82	0.18	3.76
12	2000	87987	459029	12.82	13.04	0.22	3.20
13	2001	75959	534988	13.04	13.19	0.15	4.62
14	2002	77224	612212	13.19	13.32	0.13	5.14
15	2003	82060	694272	13.32	13.45	0.13	5.31
16	2004	86630	780902	13.45	13.57	0.12	5.86
17	2005	87801	868703	13.57	13.67	0.10	6.62
18	2006	86700	955403	13.67	13.77	0.10	6.94
19	2007	90589	1045992	13.77	13.86	0.09	7.66
20	2008	97108	1143100	13.86	13.95	0.09	7.76
21	2009	108669	1251769	13.95	14.04	0.09	7.69
22	2010	97921	1349690	14.04	14.12	0.08	9.19
23	2011	99538	1449228	14.12	14.19	0.07	10.41
24	2012	102342	1551570	14.19	14.25	0.06	10.70
25	2013	88995	1640565	14.25	14.31	0.06	11.44

It was observed from the Table 6 that year wise calculation of RGR for journal article pages is in decreasing trend from 1.38 in the year 1990 to 0.06 in 2013, of course, there are fluctuations in the years 2000, 2008 and 2009. (Figure 10).

Similarly the Dt also shows fluctuation trends. The Dt for 1990 was 0.50 and increased up to 3.77 in the year 1999. In the year 2000 it decreased to 3.46 and 7.46 in 2008 and 7.35 in 2009 and since then it shows an increasing trend (Figure 11).

TABLE VI RGR AND DT FOR JOURNAL ARTICLES PAGES IN GENETIC ENGINEERING RESEARCH

S.No.	Year	Quantum of Output	Cumulative Total of Output	W <sub>1</sub>	W <sub>2</sub>	$1 - 2\bar{R}^{(pp^{-1} \text{ year}^{-1})}$ RGR	Dt(p)
1	1989	3205	3205		8.07		
2	1990	9503	12708	8.07	9.45	1.38	0.50
3	1991	17919	30627	9.45	10.33	0.88	0.79
4	1992	21834	52461	10.33	10.87	0.54	1.29
5	1993	28936	81397	10.87	11.31	0.44	1.59
6	1994	32421	113818	11.31	11.64	0.33	2.09
7	1995	37107	150925	11.64	11.92	0.28	2.44
8	1996	38700	189625	11.92	12.15	0.23	2.98
9	1997	41957	231582	12.15	12.35	0.20	3.42
10	1998	53066	284648	12.35	12.56	0.21	3.32
11	1999	57829	342477	12.56	12.74	0.18	3.77
12	2000	74287	416764	12.74	12.94	0.20	3.46
13	2001	70687	487451	12.94	13.10	0.16	4.42
14	2002	70258	557709	13.1	13.23	0.13	5.27
15	2003	73481	631190	13.23	13.36	0.13	5.53
16	2004	69160	700350	13.36	13.46	0.10	6.98
17	2005	71996	772346	13.46	13.56	0.10	7.13
18	2006	72198	844544	13.56	13.65	0.09	8.01
19	2007	77673	922217	13.65	13.73	0.08	8.20
20	2008	85156	1007373	13.73	13.82	0.09	7.46
21	2009	96384	1103757	13.82	13.91	0.09	7.35
22	2010	86625	1190382	13.91	13.99	0.08	8.69
23	2011	88948	1279330	13.99	14.06	0.07	9.65
24	2012	93427	1372757	14.06	14.13	0.07	9.58
25	2013	82441	1455198	14.13	14.19	0.06	11.43

### XIII. CONCLUSION

It is noticed that there is a decreasing trend in the year wise RGR in the field of Genetic Engineering research output and Dt has shown an increasing trend. The Relative Growth Rate and Doubling Time for Indian output on Genetic Engineering shows the fluctuation trends throughout the study period. The Relative Growth Rate for the Journal articles output has shown decreasing trends and on the other hand, Doubling Time is in increasing trend. The Relative Growth Rate for the total pages and journal article pages in Genetic Engineering research is in decreasing trend whereas Doubling Time is in increasing trend except few years. It was found throughout the study period that, wherever the Relative Growth Rate is at higher rate, the Doubling Time is lower.

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