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# NOBEL LAUREATE FRANCES HAMILTON ARNOLD: A SCIENTOMETRIC PORTRAIT

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## ABSTRACT

*The study examines the 340 publications of Frances Hamilton Aronld an eminent American scientist in chemical engineer. The study examines the publications of scientist with the help of various scientometric indicators i.e. year and age wise publications distribution, decade wise distribution, positions of scientist and others. The study found her publications has received a total of 28667 citations from his publication and 'Dynamic pattern formation in a vesicle-generating microfluidic device' paper is highly cited paper with citations 1325 (4.6%), She has contributed 22 papers as singles author, scientist has contributed maximum number of papers in decade III (2000-2009) with 123 (36.17%) publications, the study also analysis the position-wise publication of scientist and found 18 (5.6%) papers reported as first author, Bloom J.D has collaborated maximum number of papers 15 with scientist.*

**Keywords:** *Scientometric, Frances H. Arnold Bibliometric, Scopus.*

## 1. INTRODUCTION

The term Scientometric was started to become popularized when the statistics analysis in Library and information science (LIS) based studies became focal points of the researchers. This term came in to existence as a Russian term for the application of quantitative methods to the history of science. The term coined by two Russian scientist Nalimov and Mulechenko in 1969 and become popular in Library and information science by T. Braun in 1973. (Sinha,A.K, 2017) Scientometric is a combination of two term 'sceinto' means scientific literature and metric means analysis of scientific literature with help of various sceintometric indicators. Kalyane and Kalyane (1993) first used the phrase 'Scientometric Portrait' to carry out biobibliometric studies on scientists. There are several studies has been completed on scientometric with Nobel laureate to know the research contribution and impact of scientist/researcher. (Garfiled,1977; Nederhoff,1985; sen and Gen 1990; Todorov and Winterhager, 1991; Follyet. al, 1991;Mahapatra, 1992 ;Kalyane, 1992; Gupta, 1993; Sinha and Ullah, 1993;F.W.Lancaster, et al., 1993; Giorgi,1993;Kalyane and Kalyane, 1993;Tiew,WaiSin, 1999; White, 2000; San,B.K.andKaranjai, 2001; Sen,B.K.andKaranjai, Aruna 2003; Sangam,etal.,2006; Kademani, Sagar and Kumar 2009; Hazarika,etal.,2010; Munnolli, Pujar and Kademani2011; Gadad and Ravi, 2016; Vellaichamy and Amsan, 2016; Dixit and Jange, 2017.)

## 2. LITERATURE REVIEW

*Kalyane and sen (1996) examine the publication of* Nobel laureate Pierre-Gilles de Gennes and found scientist has written 422 papers during the period 1956-1995. The study found productivity of scientist is peaked in his 40s, collaboration of scientist is being found to be less and publication productivity of scientist show national bias. *B.S.Kademani ;V.L. Kalyane and Vijai Kumar(2001) analysis the 246 papers of* Ahmed Hassan Zewail a Nobel laureate in the field of chemistry. The study found scientist has collaborated with 103 authors to complete their research work with maximum collaborator P. M Felker (39) papers, productivity coefficient of scientist is 0.52. *Nayak and Bankapur (2017)* analysis the 126 articles of the Agronomist G. S. Khush published during 1989 to 2014.The Study found that the maximum no. of articles was published in the Agronomy and plant science.i.e.76 (60.32%). Collaboration coefficient lies between 0.67 to 1.00 in all domains in which he has contributed. *Angadi, M; Koganuramath, M. M; Kademani, B. S.; Kumbar, B. D. and Jange, S (2006)* Analysis the publications productivity of Anthony J. Legett A noble prize winner in the field of Physics. He had published 194 publications from 1964 to 2004. Productivity coefficient was 0.60 which indicates that his productivity increased after 50 percentile age.

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Among all publications scientist has contributed 122 publications as single author. *Bansal, Sonia (2018)* analysis the publications of Arieh warshel a noble prize winner in the field of chemistry. He had published the total 393 publications during 1968 to 2016. Out of his all publications he has published 89.57% papers in collaborations and remaining 10.43% as solo author.

## 3. BIOGRAPHICAL SKETCH

Frances Hamilton Arnold, (born July 25, 1956, Pittsburgh, Pennsylvania), an eminent American chemical engineer. She was awarded with the Nobel Prize in the domain of Chemistry for her work on directed evolution of enzymes. She shared the prize jointly with American biochemist George Pearson Smith and British biochemist Gregory Paul Winter. Arnold graduated in 1979 with a B.S. degree in mechanical and aerospace engineering from Princeton University, she obtained a Bachelor of Science degree in mechanical and aerospace engineering from Princeton University in 1979 and a Ph.D. in chemical engineering from the University of California at Berkeley in 1985.

Arnold earned her postdoctoral fellow at Berkeley before moving at the California Institute of Technology (Caltech) as a visiting associate. In 1978, she was promoted as an Assistant professor and further Associate professor in 1992. She became a full professor in 1996. In addition to the Nobel Prize, Arnold received so many awards and regards, including the Charles Stark Draper Prize in 2011, the National Medal of Technology and Innovation in 2013, Elmer Gaden Award (2015), Millennium Technology Prize (2016), Society of Women Engineers Achievement Award (2017), and others. She was also elected an International Fellow of the Royal Academy of Engineering (2018).

## 4. OBJECTIVES

i) To know Year, age-wise publications productivity Frances H. Arnold;
ii) To know decade-wise publications and citations;
iii) To know position of author;
iv) To know the top fifteen Highly cited publications;
v) To find out year-wise growth of publications and citations;
vi) Preference of channels of communications.

## 5. METHODOLOGY

Citation analysis is a best method for measuring the research impact of scientist and its contribution to their respected field. To conduct the fruitful study bibliographic data were download from SCOPUS database. The retrieved data was transferred into MS-excel for analysis to meet the objectives of the study a total of 340 publications with 28677 citations of scientist were indexed in database from 1984-2019.

## 6. RESULTS AND DISSCUSSIONS

**Table-1: Frances H. Arnold**

| Year and Age-wise Distribution of Papers of Frances H. Arnold | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Year** | **Biological Age** | **1A** | **2A** | **3A** | **4A** | **5A** | **6A** | **<6** | **MA** | **TP** | **CT** | **CC** | **PPA** |
| 1984 | **28** | - | - | 1 | - | - | 1 | - | 2 | 2 | 2 | 1 | **1** |
| 1985 | **29** | - | - | 3 | - | - | 1 | - | 4 | 4 | 6 | 1 | **2** |
| 1986 | **30** | - | 1 | 1 | - | - | - | - | 2 | 2 | 8 | 1 | **3** |
| 1987 | **31** | - | - | - | 1 | - | - | - | 1 | 1 | 9 | 1 | **4** |
| 1988 | **32** | 2 | - | - | - | - | - | - | 0 | 2 | 11 | 0 | **5** |
| 1989 | **33** | | 1 | 1 | - | - | - | - | 2 | 2 | 13 | 1 | **6** |
| 1990 | **34** | 1 | 2 | 1 | - | - | - | - | 3 | 4 | 17 | 0.75 | **7** |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1991 | **35** | 1 | 6 | 2 | - | 2 | 1 | - | 11 | 12 | 29 | 0.92 | **8** |
| 1992 | **36** | 1 | 1 | 1 | - | 2 | - | - | 4 | 5 | 34 | 0.8 | **9** |
| 1993 | **37** | 3 | 1 | 1 | 1 | 1 | - | - | 4 | 7 | 41 | 0.57 | **10** |
| 1994 | **38** | | 1 | 3 | 1 | - | - | - | 5 | 5 | 46 | 1 | **11** |
| 1995 | **39** | | 4 | 1 | 3 | - | - | - | 8 | 8 | 54 | 1 | **12** |
| 1996 | **40** | 1 | 4 | 3 | 1 | 1 | - | 1 | 10 | 11 | 65 | 0.9 | **13** |
| 1997 | **41** | 1 | 6 | 2 | 2 | 1 | 1 | | 12 | 13 | 78 | 0.92 | **14** |
| 1998 | **42** | 3 | 1 | 1 | 2 | 1 | - | - | 5 | 8 | 86 | 0.62 | **15** |
| 1999 | **43** | | 5 | 3 | 2 | 2 | 1 | 1 | 14 | 14 | 100 | 1 | **16** |
| 2000 | **44** | 1 | 4 | 5 | 1 | 1 | 1 | - | 12 | 13 | 113 | 0.92 | **17** |
| 2001 | **45** | 1 | | 3 | 7 | 2 | - | - | 12 | 13 | 126 | 0.92 | **18** |
| 2002 | **46** | - | 4 | 5 | - | 3 | - | - | 12 | 12 | 138 | 1 | **19** |
| 2003 | **47** | - | 4 | 1 | 3 | 2 | 2 | 1 | 13 | 13 | 151 | 1 | **20** |
| 2004 | **48** | - | 1 | 5 | 3 | 1 | 1 | 1 | 12 | 12 | 163 | 1 | **21** |
| 2005 | **49** | - | 1 | 2 | 1 | 7 | 2 | 1 | 14 | 14 | 177 | 1 | **22** |
| 2006 | **50** | 2 | 1 | 4 | 3 | 2 | 2 | - | 12 | 14 | 191 | 0.85 | **23** |
| 2007 | **51** | - | 3 | 1 | 3 | 2 | 3 | - | 12 | 12 | 203 | 1 | **24** |
| 2008 | **52** | - | 1 | 2 | - | 1 | 1 | - | 5 | 5 | 208 | 1 | **25** |
| 2009 | **53** | 1 | 6 | 2 | 1 | - | 1 | 4 | 14 | 15 | 223 | 0.93 | **26** |
| 2010 | **54** | - | 2 | - | - | 2 | - | 3 | 7 | 7 | 230 | 1 | **27** |
| 2011 | **55** | 1 | 3 | 2 | 2 | 3 | 2 | 1 | 13 | 14 | 244 | 0.92 | **28** |
| 2012 | **56** | - | 2 | 1 | 1 | 1 | - | 4 | 9 | 9 | 253 | 1 | **29** |
| 2013 | **57** | - | 1 | 4 | 4 | 1 | - | 4 | 14 | 14 | 267 | 1 | **30** |
| 2014 | **58** | - | 3 | 4 | 3 | 4 | 5 | 2 | 21 | 21 | 288 | 1 | **31** |
| 2015 | **59** | 1 | 2 | 2 | 1 | 2 | 1 | 3 | 11 | 12 | 300 | 0.91 | **32** |
| 2016 | **60** | - | - | | 3 | 3 | 1 | 4 | 11 | 11 | 311 | 1 | **33** |
| 2017 | **61** | - | - | 3 | 2 | 3 | 2 | 3 | 13 | 13 | 324 | 1 | **34** |
| 2018 | **62** | 2 | | 2 | 2 | 3 | 4 | 1 | 12 | 14 | 338 | 0.85 | **35** |
| 2019 | **63** | - | - | 1 | - | - | 1 | - | 2 | 2 | 340 | 1 | **36** |
| **Total** | | **22** | **71** | **73** | **53** | **53** | **34** | **34** | **318** | **340** | | | |

***Note: 1A= One Author, (2A-6A= Multiple Author (MA)), TP= Total Publication, CT= Cumulative Total, CC= Collaboration Coefficient, PPA= Publication Productivity Age***

Frances Hamilton Arnold's first paper was published in 1984 at the biological age of 28, as a multi authored paper. Since then, scientist has contributed a total of 340 research papers, during 1984-2019. She has contributed 22 papers as single authored, 71two authored, 73 three authored, 53 four and five authored and 34 papers are contributed by more than 6 authored. Her collaboration coefficient is 93.52. She contributed maximum 21 papers in 2014, at her biological age 58. Her publication productivity age was also on peak in 2014, i.e., 31and no paper was contributed in 1988

**Table-2: Decade-Wise Publication**

| Decade | Decade Period | No. of Publications | Percentage | Cumulative Total | Publishing Career Age (Year: 1984) | Biological Age (DOB: 1956) |
|---|---|---|---|---|---|---|
| **I** | 1980-1989 | 13 | 3.82 | 13 | 1-9 | 28-37 |
| **II** | 1990-1999 | 87 | 25.58 | 100 | 10-19 | 38-47 |
| **III** | 2000-2009 | 123 | 36.17 | 223 | 20-29 | 48-57 |
| **IV** | 2010-2019 | 117 | 34.41 | 340 | 30-39 | 58-67 |

**Decade IV (2010-2019) is incomplete.*

The table distributed all research publications of scientist in IV decades. Scientist actively engaged in research in decade III (2000-2009) with maximum number of contributions with 123 (36.17%) papers at the publishing age of 20-29. Thus, the publication of scientist expanded decade by decade which present actively involvement of scientist in research.

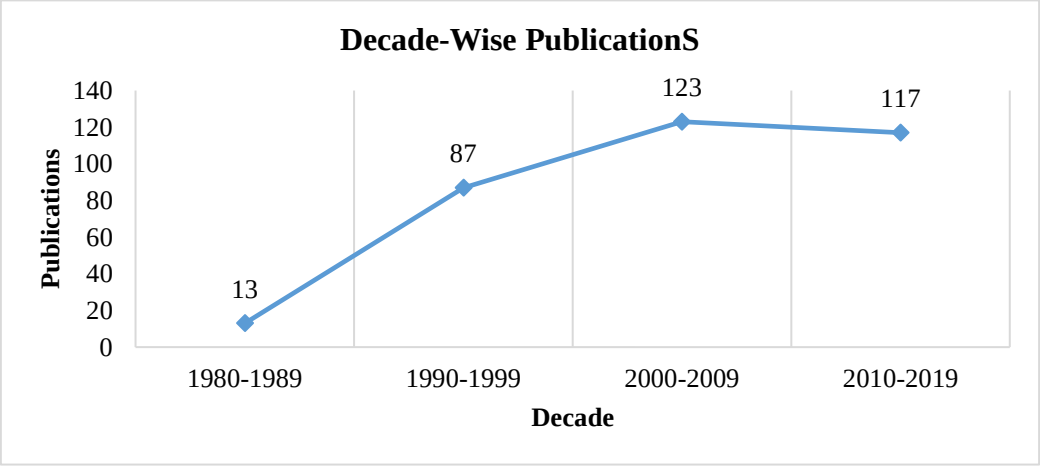


**Table-3: Position of Frances H. Arnold**

| Publications | Positions | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **First** | **First** | **Second** | **Third** | **Fourth** | **Fifth** | **sixth** | **Seventh** | **Eighth** | **Ninth** | **Tenth** | **Eleventh** | **Twelfth** | **Total** |
| **Two-authored** | 8 | 62 | – | – | – | – | – | – | – | – | – | – | 70 |
| **Three-authored** | 6 | 10 | 58 | – | – | – | – | – | – | – | – | – | 74 |
| **Four-authored** | 1 | 1 | 14 | 37 | – | – | – | – | – | – | – | – | 53 |
| **Five-authored** | 1 | 1 | 1 | 11 | 41 | – | – | – | – | – | – | – | 55 |
| **Six-authored** | 2 | – | – | 2 | | 27 | – | – | – | – | – | – | 31 |
| **Seventh-authored** | – | – | 1 | – | – | 1 | 8 | – | – | – | – | – | 10 |
| **Eight-authored** | – | – | – | – | – | 2 | – | 7 | – | – | – | – | 9 |
| **Ninth-authored** | – | – | – | – | – | – | – | 2 | 5 | – | – | – | 7 |
| **Tenth-authored** | – | – | – | – | – | – | 1 | – | 2 | 1 | – | – | 4 |
| **Eleventh-authored** | – | – | – | – | – | – | – | – | – | 1 | 1 | – | 2 |
| **Twelth-authored** | – | – | – | – | – | – | – | – | – | – | 1 | 1 | 2 |
| **Twenth-authored** | – | – | – | 1 | – | – | – | – | – | – | – | – | 1 |

| Total | 18 | 74 | 74 | 51 | 41 | 30 | 9 | 9 | 7 | 2 | 2 | 1 | 318 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

The table produce all the publication of scientist in the author position i.e. first author, second author, third author and others. Scientist has reported 18 (5.6%) papers as first author, 74 (23 %) papers as second author and third author, 51 (16%) as four author,30 (9.4%) papers as five authors and 1 paper authored as twelfth position. Form the table, scientist has preferred research work in collaborative manner or team work.

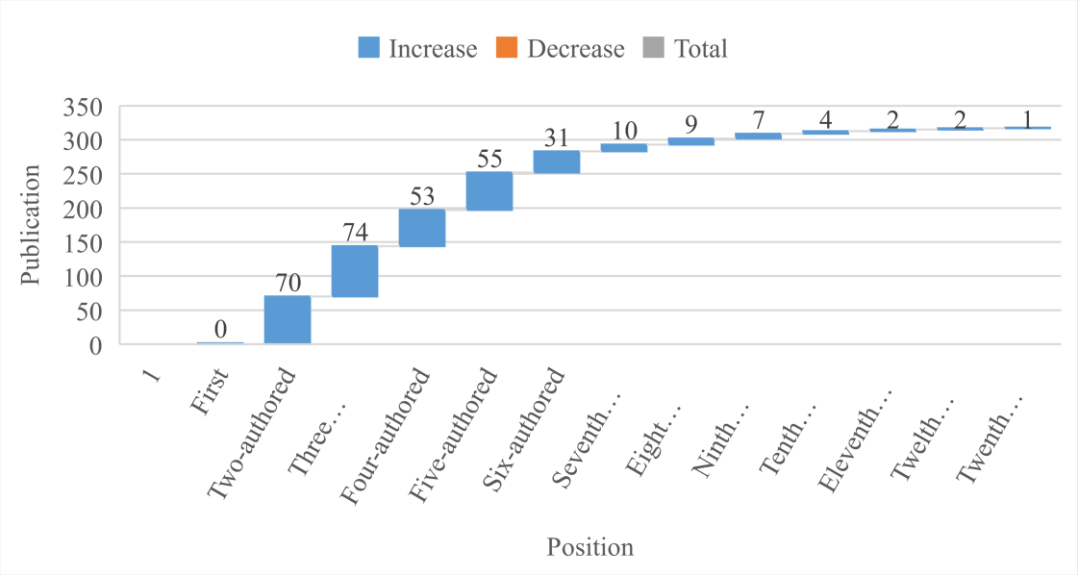


**Table-4: Top- 20 Highly Cited Papers**

| S. No | Title of the Papers | Year of Publication | Journal Name No of | Citations | Rank |
|---|---|---|---|---|---|
| 1 | Dynamic pattern formation in a vesicle-generating microfluidic device | 2001 | physical review letters | 1325 | 1 |
| 2 | A microfabricated fluorescence-activated cell sorter | 1999 | Nature Biotechnology | 770 | 2 |
| 3 | A synthetic multicellular system for programmed pattern formation | 2005 | Nature | 657 | 3 |
| 4 | Protein stability promotes evolvability | 2006 | Proceedings of the National Academy of Sciences of the United States of America | 587 | 4 |
| 5 | Molecular evolution by staggered extension process (StEP) in vitro recombination | 1998 | Nature Biotechnology | 502 | 5 |
| 6 | Why highly expressed proteins evolve slowly | 2005 | Proceedings of the National Academy of Sciences of the United States of America | 473 | 6 |
| 7 | An integrated microfabricated cell sorter | 2002 | Analytical Chemistry | 451 | 7 |
| 8 | Metal-affinity separations: A new dimension in protein processing | 1991 | Nature Biotechnology | 430 | 8 |
| 9 | Exploring protein fitness landscapes by directed evolution | 2009 | Nature Reviews Molecular Cell Biology | 409 | 9 |
| 10 | Programmed population control by cell-cell communication and regulated killing | 2004 | Nature | 409 | 9 |
| 11 | Microbiology: Long-term monitoring of bacteria undergoing programmed population control in a microchemostat | 2005 | Science | 405 | 10 |
| 12 | Engineering microbial consortia: a new frontier in synthetic biology | 2008 | Trends in Biotechnology | 377 | 11 |
| 13 | Directed evolution of a thermostable esterase | 1998 | Proceedings of the National Academy of Sciences of the United States of America | 362 | 12 |

| | | | | | |
|---|---|---|---|---|---|
| **14** | Design by Directed Evolution | 1998 | Accounts of Chemical Research | 332 | 13 |
| **15** | Laboratory evolution of peroxide-mediated cytochrome P450 hydroxylation | 1999 | Nature | 321 | 14 |
| **16** | Directed Evolution of a Para-Nitrobenzyl Esterase for Aqueous-Organic Solvents | 1996 | Nature Biotechnology | 316 | 15 |
| **17** | Combinatorial and computational challenges for biocatalyst design | 2001 | Nature | 309 | 16 |
| **18** | Directed evolution of a genetic circuit | 2002 | Proceedings of the National Academy of Sciences of the United States of America | 300 | 17 |
| **19** | Tuning the activity of an enzyme for unusual environments: Sequential random mutagenesis of subtilisin E for catalysis in dimethylformamide | 1993 | Proceedings of the National Academy of Sciences of the United States of America | 291 | 18 |
| **20** | Laboratory evolution of a soluble, self-sufficient, highly active alkane hydroxylase | 2002 | Nature Biotechnology | 284 | 19 |

Citation is one of the major factor for evaluation of research publications and commonly used as source for deriving impact factor of journals and H-index of an author and also used to measure of other indexes. The table ranked the top 20 publication of scientist based on citation received his publication. Scientist has received a total of 28667 citations from his publication. The paper ***"Dynamic pattern formation in a vesicle-generating microfluidic device"*** published in journal ***physical review letters*** has cited highest time with ranked one among in all publications with citations 1325 (4.6%), followed by paper ***"A microfabricated fluorescence-activated cell sorter"*** published in **Nature Biotechnology** with 770 (2.6%) citations and "***A synthetic multicellular system for programmed pattern formation"*** published in **nature** received third (3) rank with 657 (2.3%) citations.

**Table-5: Year-Wise Citations of Frances H. Arnold**

| S. No. | Year | Citation | Cumulative Citation | S. No. | Year | Citation | Cumulative Citation |
|---|---|---|---|---|---|---|---|
| **1** | 1984 | 2 (0.007%) | 2 | **19** | 2002 | 1710 (5.97%) | 15429 |
| **2** | 1985 | 309 (1.07%)) | 311 | **20** | 2003 | 1064 (3.7%) | 16493 |
| **3** | 1986 | 160 (0.05%) | 471 | **21** | 2004 | 1064 (3.7%) | 17557 |
| **4** | 1987 | 54 (0.19%) | 525 | **22** | 2005 | 2594 (9%) | 20151 |
| **5** | 1988 | 53 (0.18%) | 578 | **23** | 2006 | 1411 (4.9%) | 21562 |
| **6** | 1989 | 66 (0.23%) | 644 | **24** | 2007 | 788 (2.75%) | 22350 |
| **7** | 1990 | 273 (0.95%) | 917 | **25** | 2008 | 796 (2.78%) | 23146 |
| **8** | 1991 | 1170 (4.1%) | 2087 | **26** | 2009 | 1554 (5.4%) | 24700 |
| **9** | 1992 | 207 (0.72%) | 2294 | **27** | 2010 | 337 (1.18%)) | 25037 |
| **10** | 1993 | 443 (1.5%) | 2737 | **28** | 2011 | 848 (2.96%) | 25885 |
| **11** | 1994 | 366 (1.3%) | 3103 | **29** | 2012 | 227 (0.8%) | 26112 |
| **12** | 1995 | 632 (2.2%) | 3735 | **30** | 2013 | 859 (3%) | 26971 |
| **13** | 1996 | 975 (3.4%) | 4710 | **31** | 2014 | 654 (2.3%) | 27625 |
| **14** | 1997 | 1113 (3.89%) | 5823 | **32** | 2015 | 454 (1.6%) | 28079 |
| **15** | 1998 | 1438 (5%) | 7261 | **33** | 2016 | 240 (0.83%) | 28319 |
| **16** | 1999 | 2347 (8.2%) | 9608 | **34** | 2017 | 266 (0.92%) | 28585 |
| **17** | 2000 | 1321 (4.6%) | 10929 | **35** | 2018 | 82 (0.3%) | 28667 |
| **18** | 2001 | 2790 (9.7%) | 13719 | **36** | 2019 | 0 | |

The table show year-wise citation of Francis H Arnold's during 1984-2019. In his starting carrier he has received only 2 (0.007%) citations but over the period citations has increased scientist has received

a total of 28667 citations. Scientist has received highest number of citations 2790 (9.7%) in 2001, followed by 2595 (9%) in 2005.

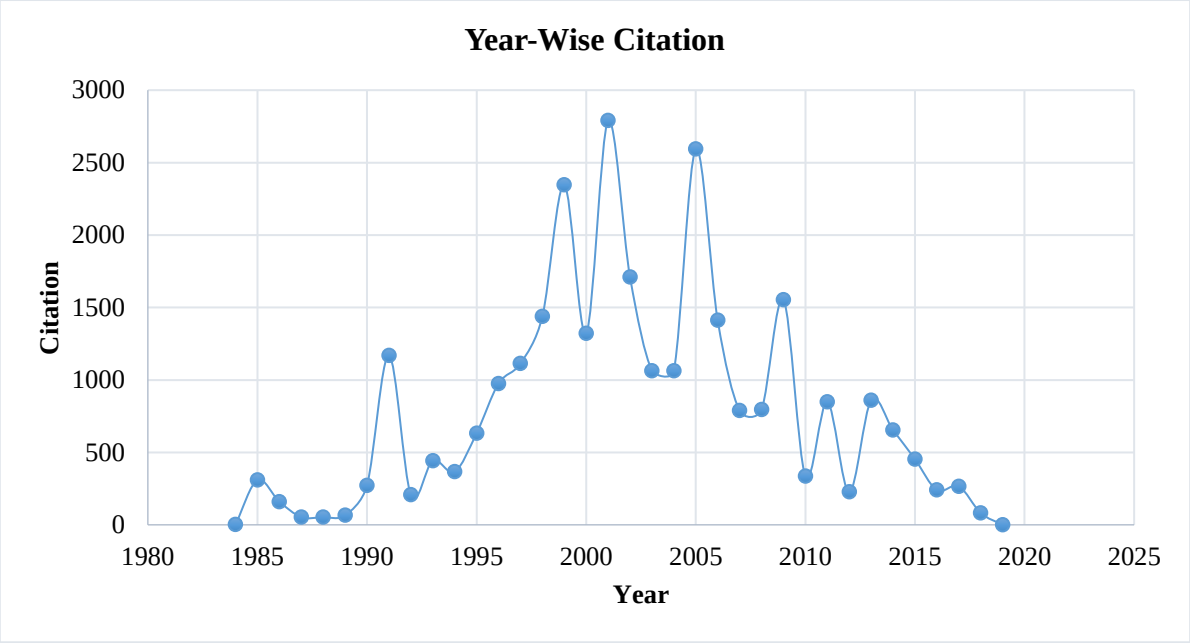


**Table-6: Preferred Chanel of Communication**

| S. No | Source | IF | No of Papers | Rank | No of Citations | Average Citation | FPY-LFY |
|---|---|---|---|---|---|---|---|
| **1** | Proceedings of the National Academy of Sciences of the United States of America | 9.504 | 24 | 1 | 3623 | 150.95 | 1993-2018 |
| **2** | Journal of the American Chemical Society | 14.357 | 21 | 2 | 1132 | 53.9 | 1991-2018 |
| **3** | Nature Biotechnology | 35.724 | 20 | 3 | 3567 | 178.35 | 1991-2010 |
| **4** | Biotechnology and Bioengineering | 3.952 | 11 | 4 | 591 | 53.72 | 1990-2014 |
| **5** | Protein Engineering, Design and Selection | 1.881 | 11 | 4 | 428 | 38.9 | 1988-2015 |
| **6** | AngewandteChemie - International Edition | 12.102 | 11 | 4 | 878 | 79.81 | 2003-2018 |
| **7** | Current Opinion in Biotechnology | 8.38 | 10 | 5 | 791 | 79.1 | 1993-2017 |
| **8** | Journal of Molecular Biology | 4.894 | 10 | 5 | 858 | 85.8 | 1997-2015 |
| **9** | Applied and Environmental Microbiology | 3.633 | 8 | 6 | 450 | 56.25 | 2001-2011 |
| **10** | Current Opinion in Chemical Biology | 7.572 | 8 | 6 | 831 | 103.87 | 1998-2019 |
| **11** | Journal of Chromatography A | 3.716 | 8 | 6 | 626 | 78.25 | 1985-1997 |
| **12** | Nature | 41.577 | 8 | 6 | 1742 | 217.25 | 1999-2019 |
| **13** | Science | 41.058 | 7 | 7 | 1071 | 153 | 1991-2018 |
| **14** | Trends in Biotechnology | 13.578 | 6 | 8 | 903 | 105.5 | 1990-2019 |
| **16** | Chemistry and Biology | 5.915 | 6 | 8 | 53.6 | 268 | 1996-2015 |
| **15** | ChemBioChem | 2.774 | 5 | 9 | 335 | 67 | 2002-2014 |
| **17** | Current Opinion in Structural Biology | 7.179 | 5 | 9 | 93.4 | 467 | 1996- |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | 2015 |
| **18** | Journal of Biomolecular Screening | 2.355 | 5 | 9 | 37.8 | 189 | 2001-2004 |
| **19** | Methods in Enzymology | 1.984 | 5 | 9 | 16.2 | 81 | 1994-2013 |
| **20** | Methods in Molecular Biology | NA | 5 | 9 | 2.6 | 13 | 2002-2018 |
| **21** | Advanced Synthesis and Catalysis | 5.123 | 4 | 10 | 66.25 | 265 | 2001-2012 |
| **22** | Metabolic Engineering | 7.674 | 4 | 10 | 54.5 | 218 | 2011-2014 |
| **23** | Protein Engineering | NA | 4 | 10 | 149.75 | 599 | 1996-2001 |
| **24** | Protein Science | 2.41 | 4 | 10 | 38.75 | 155 | 2003-2016 |
| **25** | ACS Synthetic Biology | 5.316 | 3 | 11 | 23.66 | 71 | 2012-2017 |
| **26** | Annals of the New York Academy of Sciences | 4.277 | 3 | 11 | 10.33 | 31 | 1988-1999 |
| **27** | Biochemistry | 2.997 | 3 | 11 | 38 | 114 | 1987-2016 |
| **28** | Nucleic Acids Research | 11.561 | 3 | 11 | 144.66 | 344 | 1997-1999 |
| **29** | ACS Catalysis | 11.384 | 2 | 12 | 13 | 26 | 2016-2018 |
| **30** | ACS Cental Science | 11.228 | 2 | 12 | 37.5 | 67 | 2015-2018 |
| **31** | ACS National Meeting Book of Abstracts | NA | 2 | 12 | 0 | 0 | 2007-2011 |
| **32** | ACS Symposium Series | NA | 2 | 12 | 11 | 22 | 1985-1998 |

The table listed top 32 journals of scientist which have covered maximum number of papers. Scientist has preferred a total of 109 journals to published his research output. Maximum number of papers 24 (IF:9.504) of Frances H. Arnold has published in ***Proceedings of the National Academy of Sciences of the United States of America*** with maximum number of citations 3623 during the FPY-LFY 1993-2018, followed by ***Journal of the American Chemical*** Society with 21 papers (IF:14.357) during 1991-2018. A total of 77 journals has been identified with each publication of scientist.

**Table-7: Prominent Authors**

| S. No | Author | Total No of Papers | Rank | S. No | Author | Total No of Papers | Rank |
|---|---|---|---|---|---|---|---|
| **1** | Bloom J. D | 15 | 1 | **23** | Gradinaru, V. | 7 | 9 |
| **2** | Snow C. D | 14 | 2 | **24** | Johnson, R.D. | 7 | 9 |
| **3** | Brinkmann-Chen, S. | 13 | 3 | **25** | Mayo, S.L. | 7 | 9 |
| **4** | Buller, A.R. | 13 | 3 | **26** | Romney, D.K. | 7 | 9 |
| **5** | Meinhold, P. | 12 | 4 | **27** | Todd, R.J. | 7 | 9 |
| **6** | Cahn, J.K.B. | 11 | 5 | **28** | Umeno, D. | 7 | 9 |
| **7** | McIntosh, J.A. | 10 | 6 | **29** | You, L. | 7 | 9 |
| **8** | Romero, P.A. | 10 | 6 | **30** | Alcalde, M. | 6 | 10 |
| **9** | Romero, P.A. | 9 | 7 | **31** | Arnold, F. | 6 | 10 |
| **10** | Blanch, H.W. | 8 | 8 | **32** | Chen, K. | 6 | 10 |
| **11** | Collins, C.H. | 8 | 8 | **33** | Fasan, R. | 6 | 10 |
| **12** | Otey, C.R. | 8 | 8 | **34** | Gershenson, A. | 6 | 10 |
| **13** | Pack, D.W. | 8 | 8 | **35** | Giver, L. | 6 | 10 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **14** | Renata, H. | 8 | 8 | **36** | Lewis, J.C. | 6 | 10 |
| **15** | Wang, Z.J. | 8 | 8 | **37** | Peters, M.W. | 6 | 10 |
| **16** | Zhao, H. | 8 | 8 | **38** | Silberg, J.J. | 6 | 10 |
| **17** | Brustad, E.M. | 7 | 9 | **39** | Smith, M.A. | 6 | 10 |
| **18** | Chen, K. | 7 | 9 | **40** | Voigt, C.A. | 6 | 10 |
| **19** | Cirino, P.C. | 7 | 9 | **41** | Wilke, C.O. | 6 | 10 |
| **20** | Coelho, P.S. | 7 | 9 | **42** | Wilke, C.R. | 6 | 10 |
| **21** | Drummond, D.A. | 7 | 9 | **43** | Wintrode, P.L. | 6 | 10 |
| **22** | Farwell, C.C. | 7 | 9 | **44** | Zhang, R.K. | 6 | 10 |

Scientist has collaborated more than 150 authors to complete her research work. The table listed 44 prominent author who has collaborated with scientist to complete their research work. Bloom J.D has collaborated maximum number of papers 15 with scientist, followed by Snow C.D with 14 papers, Brinkmann-Chen, S and Buller, A.R. has collaborated 13 papers with scientist.

## 7. CONCLUSION

From the study it has to be observed that scientist has contributed a total of 340 papers from 1984-2019 in their respected field during this period he has contributed 22 papers as single author. Scientist published paper '*Dynamic pattern formation in a vesicle-generating microfluidic device'* was published in 'Physical Review Letters' journal in 2001 has received maximum number of citation with 1325, Scientist has received maximum number of citation 2709 in 2001, she preferred the 'Proceedings of the National Academy of Sciences of the United States of America' (Impact Factor -9.504) for publishing of his research work and published maximum number of papers with 24.

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