Chronological Distribution of Emerging Referenced Disciplines in Biochemistry & Molecular Biology over the Last 100 Years

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Abstract

This article presents a condensed evolution of the interdisciplinarity of Biochemistry & Molecular Biology (BMB) by showing its chronological sequence of cited disciplines from 1910 until 2012. Interdisciplinary research has become a general approach for solving complex problems in modern science. The results of our research might help policy makers and funding agencies understand more comprehensively the interdisciplinary nature of specialties and disciplines. Using science overlay maps based on the NSF classification systems, our analysis confirms that interdisciplinarity begins with neighbouring fields and evolves to more distant cognitive areas.

Keywords: interdisciplinarity, science overlay maps, biochemistry & molecular biology, discipline citation sequence

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1 Introduction

Interdisciplinary research has become a general approach for solving complex problems in modern science, and, as such, has been encouraged by science policy (Rafols & Meyer, 2007) both by creating multidisciplinary centers and by funding multidisciplinary research projects (Bordons, Zulueta, Romero, & Barrigón, 1999). Porter and Rafols (2009) mention that interdisciplinary research seems almost universally acclaimed as "the way to go." Measuring and understanding interdisciplinary research is a topic that has received more attention in bibliometrics studies lately.

In an attempt to answer the question "Is science becoming more interdisciplinary?" Porter and Rafols (2009) investigate interdisciplinarity evolution over a thirty year period across six research domains. The results attest to notable changes in research practices over that period of time, specifically in the number of cited disciplines and references per article, and co-authors per article. However, the Rao-Stirling Index only shows a modest increase. The authors hint that this is due to the fact that distribution of citations of an article remains mainly within neighbouring disciplinary areas. Similarly, Larivière and Gingras (2014) show that, after declining between 1945 and 1975, interdisciplinarity has been rising, mainly at the expense of the focus on specialties. Another recent study by Levitt, Thelwall, and Oppenheim (2011) analyzed the evolution of interdisciplinarity in the Social Science Citation Index (SSCI) categories for three specific years (1980, 1990 and 2000). The authors showed that the median level of interdisciplinarity of these fields had decreased between 1980 and 1990, but then climbed back in 2000 to its 1980 level. Mansilla, Feller, and Gardner (2006) analyzed changes in level of interdisciplinarity between 1985 and 1995 and found that very few disciplines displayed significant changes in levels of interdisciplinarity during that time. Chang and Huang (2012) used three bibliometric methods (direct citation, bibliographic coupling, and co-authorship analysis) to investigate interdisciplinary changes in Library and Information Science over the

past thirty years. This article presents a condensed evolution of the interdisciplinarity of Biochemistry & Molecular Biology (BMB) by showing the chronological sequence of cited disciplines.

2 Data and Method

2.1 Data Collection

A total of 1,539,526 Biochemistry & Molecular Biology (BMB) papers (published between 1910 and 2012), along with 40,855,852 corresponding references (journal article only) were obtained from Thomson Reuters Web of Science which include over one century of both papers and references. The disciplinary classification of journals used in this paper is that of the U.S. National Science Foundation (NSF) which categorizes each journal into one discipline and one specialty. The main advantage of this classification over that of Thomson Reuters is that it classifies each journal into one discipline only, thus avoiding multiple counting of publications. This classification includes 143 specialties spanning fourteen disciplines. The paper mainly explores the evolution of interdisciplinarity by looking at the time at which different disciplines are first cited by BMB from 1910 to 2012. One limitation of this study is that this classification represents the current state of journal classification which might or might not be stable through time. That being said, given that very few disciplines have ceased to exist—while a lot of disciplines were created—using the current classification should not create a lot of anachronism. Further analysis with chronological sampling would be a useful addition.

2.2 Science Overlay Map Based on the NSF Classification System

Maps of science allow visualization of elements (usually scientific disciplines) and the relation-ships that exist between them (Klavans & Boyack, 2009). Science overlay map is an efficient tool to display disciplinary distribution and evolution. Since the local science maps are problematic for comparisons because they are not stable in the units or positions of representation, some authors recommend using science overlay maps to overcome this problem (Rafols, Porter, & Leydesdorff, 2010; Leydesdorff, Carley, & Rafols, 2013). Science overlay maps use the units and positions derived from a global map of science, but overlay on them the data corresponding to the organizations or themes under study.

Rafols et al. (2010) generate a matrix of citing SCs (Web of Science Subject Categories) to cited SCs using the Journal Citation Report and construct a basemap of 221 SCs. Since we adopted the NSF Classification System for our study, we could not utilize this basemap and therefore had to produce our own basemap. We constructed a discipline-to-discipline co-citation matrix using ten years of data (2003–2012) from Web of Science. Salton's cosine was used for normalization in the co-citation value. We used VOS Viewer to generate a global map of science, based on NSF classification system. Figure 1 shows the global map of science based on the 143 specialties of the NSF classification. Each node in the map shows one specialty, its size being determined by the total citations received throughout the en-tire period analyzed. The relative position of the specialty is determined by their similarity, based on the VOS MDS algorithm (van Eck & Waltman, 2010; van Eck, Waltman, Dekker, & van den Berg, 2010). The colours in figure 1 correspond to the fourteen NSF disciplines.

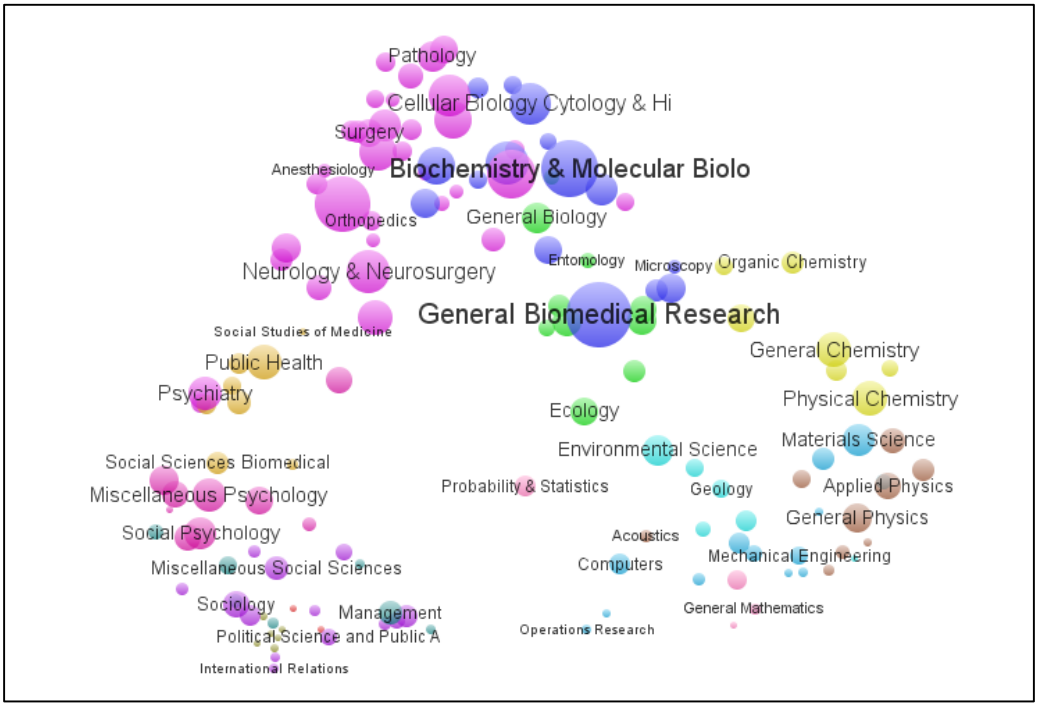

Figure 1: Global map of science based on the NSF classification system

In the upper part of figure 1 we find Biomedical Research, Clinical Medicine and Biology, whereas in the bottom left we find Social Sciences, Psychology, Professional Fields, Humanities and Art. The bottom right consists of Chemistry, Physics, Engineering and Technology, Earth and Space Sciences and Mathematics. Health is found between the upper and bottom left. The global science map from NSF classification is similar to the global science map reported in Rafols et al. (2010) and the consensus map of science produced by Klavans and Boyack (2009, p. 469).

3 Results

3.1 Interdisciplinary Evolution Trace of BMB

Our analysis shows that the number of specialties cited in Biochemistry & Molecular Biology (BMB) grows from 1 to 93 (spanning 12 NSF disciplines) over the one hundred year period un-der study. This is typical of an evolution toward interdisciplinarity. It is interesting to present the chronological sequence of cited disciplines by BMB researchers. We chose to display the evolution of interdisciplinarity from the level of NSF discipline and then specially aimed at some benchmarks in the development of BMB as a discipline. Let us consider the core disciplines in the emerging sequence of interdisciplinary relations. Figure 2 illustrates the chronological sequence of disciplines. The year of appearance corresponds to the time the discipline reached a certain significance in terms of citations received (250 citations was deemed significant).

BMB is a specialty of Biomedical Research, so at first BMB only cited publications from the discipline itself in 1910, and then started to cite publications from other disciplines such as Chemistry (1924), Clinical Medicine (1937) and Biology (1949). These three NSF disciplines are close to BMB on the global science map based on the NSF classification system (refer to figure 1). With the development of BMB, some publications from more distant disciplines such as Physics emerged in the referenced disciplines in 1961. Psychology, Earth and Space Sciences, Engineering and Technology and Mathematics also appeared one after the other in the referenced disciplines between 1982 and 1993. It is worth noting that two "professional fields" (Library and Information Science, Management) and Social Sciences, which may be

considered as distant disciplines, emerge in the referenced disciplines respectively in 2003 and 2012 probably reflecting the recent debates on the uses of bibliometrics to evaluate research in BMB.

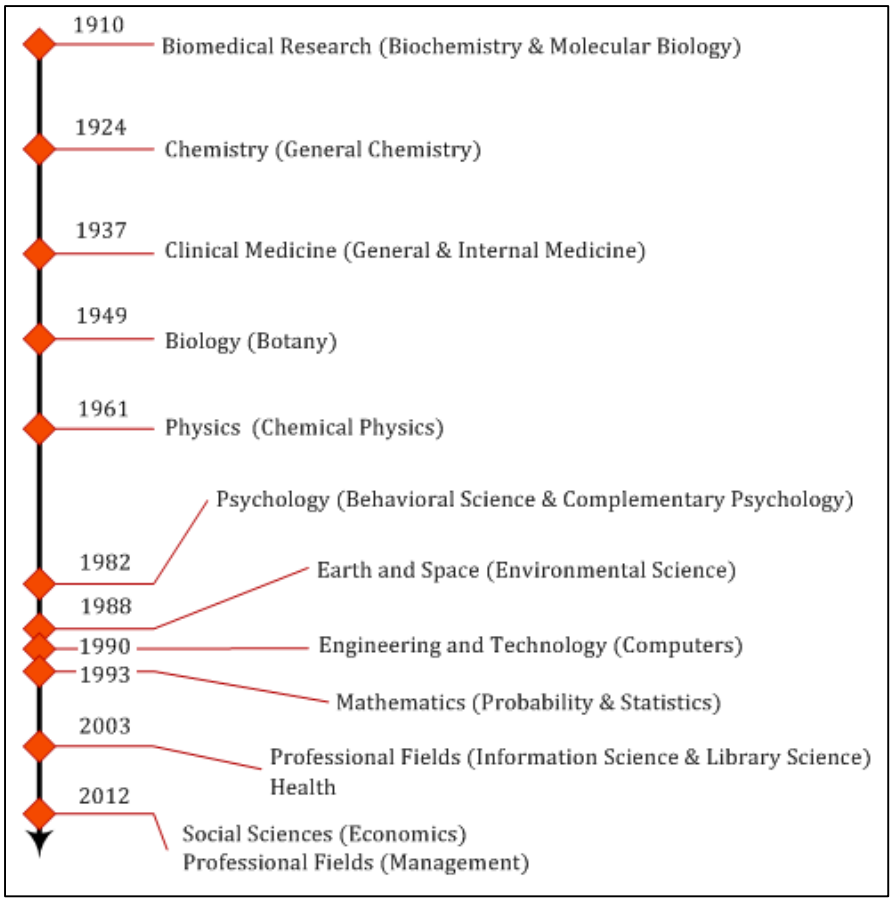

Figure 2: Discipline emerging sequence for Biochemistry & Molecular Biology

4 Discussion and Conclusion

We examined the evolution of interdisciplinarity in Biochemistry & Molecular Biology (BMB) over a century using the disciplines of papers referenced in BMB journals. This study confirms that interdisciplinarity begins with neighbouring fields and evolves to more distant cognitive areas. These results might help policy makers and funding agencies understand more comprehensively the interdisciplinary nature of specialties and disciplines.

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