

Science Beyond Impact Factors

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Over the next month, some exciting changes will take place in the functionality of Editorial Manager, the online submission system for Pharmaceutical Research. Authors will be able to select a preferred Editor for handling their manuscripts, provide suggestions for preferred (or non-preferred) reviewers, amongst other changes. On the review side, we will implement new areas of reviewer feedback that will allow for better communication with editors. Ultimately, these changes are designed to better serve our authors in making the review process more transparent and providing more constructive feedback on individual aspects of manuscripts. There will also be a few additional changes (1) on “Team *PharmRes*”: After serving the journal for more than 7 years, Dr. Toshihiro Kimura will retire his position as Professor and Dean of Okayama University and step down as Editor for Pharmaceutical Research. Toshihiro has been a devoted Editor in the area of drug delivery and served as a strong advocate for our Asian authors and reviewers. He is currently assisting the editorial office in the search for his successor in related areas of expertise. Second, Dr. Christine Vauthier will be taking over as Editor for Dr. Patrick Couvreur. Christine is a prolific scholar in the area of drug delivery and nanotechnology who has worked closely with Patrick during his tenure with Pharmaceutical Research; as a result, she is very familiar with the editorial process allowing for a smooth transition. Welcome on board, Christine! Lastly, Dr. Uday Kompella has championed the journal for several years in the capacity as Editor, Expert Reviews. Thanks to his efforts, the journal has seen a steady stream of high-quality review articles in burgeoning new areas of research. He will now assume the role of regular editor for the journal in the areas of nanotechnology for drug delivery, gene delivery, and imaging.

A long-standing debate about the value of impact factors in appraising the scientific value of publications may get more complicated with the introduction of the Eigenfactor Score (somewhat similar to a journal's impact factor but corrected for self-citations) and the Article Influence Score (AIS), which calculates the relative importance of the journal on a per-article basis. The AIS is determined by dividing the Eigenfactor Score by the number of articles published in the journal and normalized to

ensure that the overall, AIS of all journals is 1.0. This would indicate that publications in a journal with an AIS >1.0 make a relatively higher impact on the advancement of science. Eigenfactor analysis is a highly useful tool to map and rank scientific knowledge (2) and is based on the same algorithms used in social network visualization; each node in the network represents a compressed description of the information flow (i.e. citations) from one scientific discipline to another. For example, an analysis of the general discipline of pharmacology illustrates the scientific fields that are influenced by each other as measured by flow of cross-disciplinary citations (Fig. 1). When analyzing the publications that contribute most prominently to ‘pharmacological sciences’-centered citation traffic it is exciting to note that drug delivery and pharmaceutical sciences journals dominate (Fig. 1, inset). This is not surprising given the cross-disciplinary nature of our journal and illustrates the diverse audience reached by *Pharmaceutical Research*.

Journal impact factors (IF)¹ have become the gold standard in establishing the status of a journal. However, the calculation of impact factors (as determined by Thomson Corporation) is not entirely transparent, fraught with perhaps arbitrary assignment of source items in the denominator and has been questioned in several recent articles (3–5). It is unclear, for example, why source items that receive citations in the numerator (thereby increasing the impact) do not show up in the denominator. Although Thomson Corp. has responded to some allegations it cannot deny that the impact factor depends crucially on which article types Thomson Scientific deems as “citable” and it appears that certain high-impact journals have successfully played the ‘impact factor game’ (6,7) by successfully keeping various article ‘types’ off their books (i.e. denominator). Let us analyze, for example, *Nature Reviews Drug Discovery* with a spectacular 2007 IF of 23.3. According to Thomson's 2007 Journal Citation Reports™ data, the journal published merely 66 articles in 2005 and 67 in 2006; however, data verification on Thomson's Web of Science indicates 507 citable items over this 2 year period (not 133), many of which are earmarked ‘editorial material’ even though some contain over 50 citations (sic). Thus, the number of citable items in this publication represents merely a quarter of its published articles. Adjusting the

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¹ A journal's impact factor in any given year is calculated by dividing the number of citations in that year to any published items in the previous 2 years (the numerator) by the number of substantive articles (source items) published in those 2 years (the denominator).

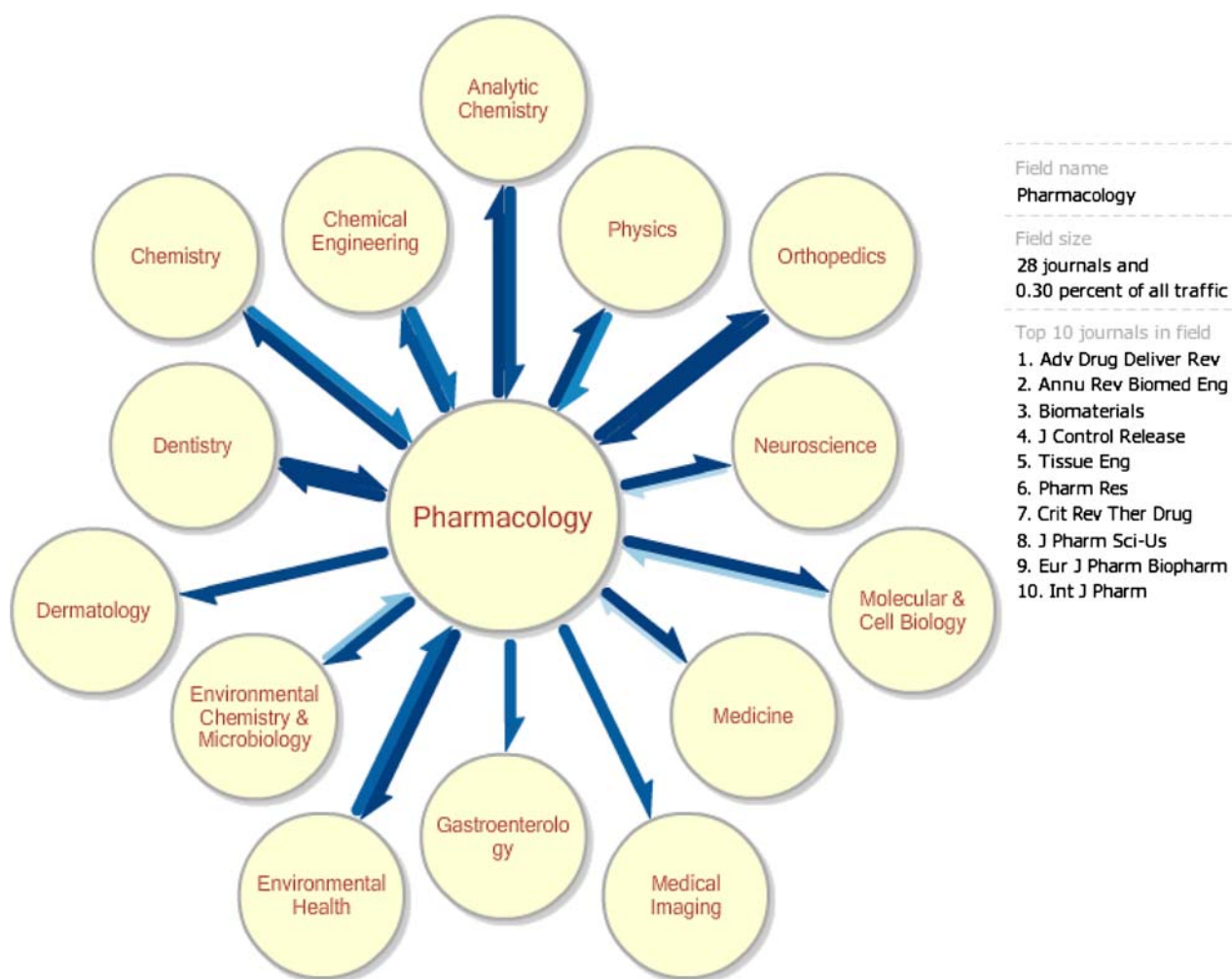


Fig. 1. Citation relationships between different scientific disciplines and relative flow of citation traffic to and from pharmacological sciences. The figure was generated using the interactive map feature at the www.eigenfactor.org website. Top ten citation traffic journals provided by eigenfactor analysis and Thomson Scientific™.

IF of *Nat Rev Drug Disc* for apparently mis-categorized articles would reduce its IF to approximately 6–8, which is well in line with comparable review only journals, such as *Advanced Drug Delivery Reviews* (IF 8.2; Table I. Clearly, judging a journal's status by impact factor alone (or AIS, which relies on similar metrics) must be carried out with extreme caution. An alternative

bibliometric measure not employed yet to compare journal rankings is the Hirsch-index (*h* index), which was originally introduced as a representative measure of individual scientific achievement (8). The *h* index is the number of papers coauthored by a researcher with at least *h* citations each (9), thereby normalizing a researcher's overall scientific productivity (total

Table I. Comparison of Citation Metrics for Publications in the Pharmaceutical Sciences^a

Publication name	Published items	Times cited (×1,000)	Average # cites	<i>h</i> index ^b	Impact factor ^c	Date range analyzed
<i>AAPS J/PharmSci</i>	482	2.3	4.9	21	3.8	'99-'09
<i>Adv Drug Del Rev</i>	1,797	56	31.4	101 ^c	8.2	'91-'09
<i>Eur J Pharm Sci</i>	2,337	18	7.7	46	3.1	'93-'09
<i>Int J Pharm</i>	8,925	108	12.1	77	2.4	'89-'09
<i>J Control Rel</i>	4,537	90	20.7	98	4.8	'89-'09
<i>J Pharm Sci</i>	6,941	85	12.3	87	2.9	'90-'09
<i>Nat Rev Drug Discov</i>	1,721	33	19.3	96	23.3	'02-'09
<i>Pharm Res</i>	5,901	114	19.3	107	3.4	'91-'09

^a Data were retrieved from ISI Web of Knowledge™ in February 2009

^b *h* index is 84 if calculated over the same time period ('02-'09) as *Nat Rev Drug Discov*

^c Impact factors were retrieved from Thomson Corporation's 2007 Journal Citation Report™

number of citations) from the impact of a few highly cited materials. This algorithm can be applied easily to scientific publications in order to compare their sustained impact, because it removes the assignment of citable 'source items' and allocates less weight to the total number of citations. As demonstrated in Table I, the *h* index of *Pharmaceutical Research* is comparable to or higher than that of its peers, even though the relative impact factors would indicate otherwise. Interestingly, the *h* index of *Adv Drug Del Rev* is higher than that of *Nat Rev Drug Discov*, despite a whopping 15 point difference in their respective impact factors! This illustrates that impact factors and related parameters should not be used as the sole indicator of a publication's scientific value. To this end, *Pharmaceutical Research* boasts not one, but various robust bibliometric rank statistics that place it ahead of the competition in several areas. These data solidify *Pharmaceutical Research*'s position as a comprehensive journal that will continue to publish cutting-edge articles at the forefront of interdisciplinary science for its intended audience, the industrial and academic pharmaceutical scientist.

REFERENCES

1. P. W. Swaan. Pharmaceutical research—looking ahead. *Pharm. Res.* **26**:491 (2009).
2. M. Rosvall, and C. T. Bergstrom. An information-theoretic framework for resolving community structure in complex networks. *Proc. Natl. Acad. Sci. U. S. A.* **104**:7327–7331 (2007).
3. R. A. Brumback. Worshiping false idols: the impact factor dilemma. *J. Child. Neurol.* **23**:365–367 (2008).
4. J. B. Green. Limiting the impact of the impact factor. *Science.* **322**:1463 (2008).
5. M. Rossner, H. Van Epps, and E. Hill. Show me the data. *J. Exp. Med.* **204**:3052–3053 (2007).
6. H. Tse. A possible way out of the impact-factor game. *Nature.* **454**:938–939 (2008).
7. The impact factor game. It is time to find a better way to assess the scientific literature. *PLoS Med.* **3**:e291 (2006).
8. J. E. Hirsch. An index to quantify an individual's scientific research output. *Proc. Natl. Acad. Sci. U. S. A.* **102**:16569–16572 (2005).
9. J. E. Hirsch. Does the H index have predictive power. *Proc. Natl. Acad. Sci. U. S. A.* **104**:19193–19198 (2007).