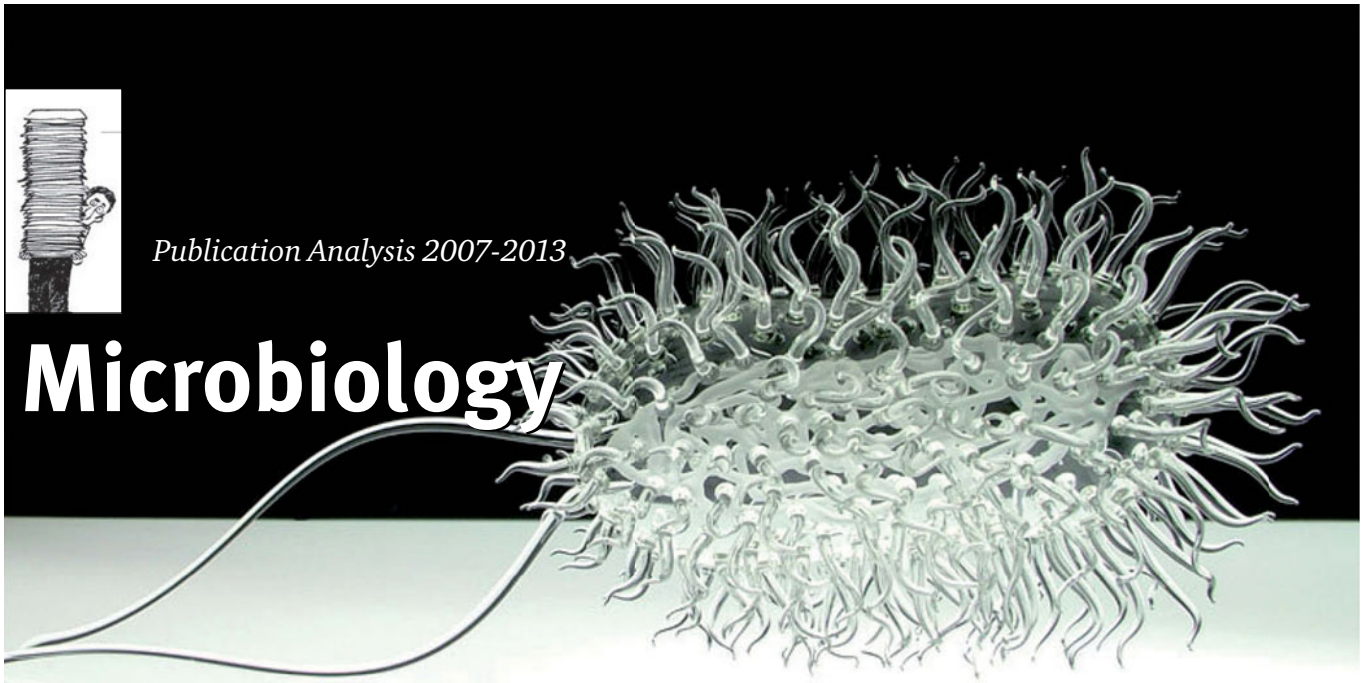


Publication Analysis 2007-2013

Microbiology

Glass microbe by Luke Jerram

Good and bad bugs battle it out in our publication analysis. Half of our most-cited authors study bacterial pathogens, the other half focusses on helpful prokaryotes. Irish microbiology has done remarkably well.

And what have they ever given us in return?! — Waste disposal? — Oh. Yeah, yeah. They did give us that. Uh, that's true. Yeah. — And oxygen.— Oh, yeah, oxygen. Remember what earth used to be like? — Yeah. All right. I'll grant you oxygen and waste disposal are two things that the microbes have done. — And cheese. — Well, yeah. Obviously the cheese. I mean, the cheese goes without saying, doesn't it? But apart from waste disposal, oxygen, and cheese. — Digestion. — Antibiotics. — Powerful research tools. — Oh, yes. Yeah… — All right, but apart from the waste disposal, the oxygen, cheese, digestion, antibiotics and powerful research tools, what have the microbes ever done for us?

This is, of course, a rhetoric question. Bacteria, viruses and other microorganisms simply rule the world we live in. Could you imagine a world without them? French microbiologist, Louis Pasteur, couldn't. "Life would not long remain possible in the absence of microbes," he said. So, there are more than enough scientific reasons to make microbiology the centre of one's professional life. And it might be a clever career choice, too. "Microbiology sits neatly on the interface between fundamental science and applied science/biotechnology (…) The most important aspect of the degree is its relevance to society. Whether it's regarding issues of the food or pharma industries, the environment, or medicine, microbiology is centrally important and is rarely far from the news. This relevance in diverse spheres means graduates have little difficulty in pursuing careers in research and industry," the microbiology brochure from the University College Cork advertises.

A change in leadership

And indeed, microbiology research is buzzing in Europe (and elsewhere) but what have been the discipline's hottest topics and whose microbial papers gathered the most citations? We're soon to find out. First, a look at the nations' performance. As with previous publication analyses, for this particular ranking we had to rely on specialist journals, such as *FEMS Microbiology Reviews*, only. The reason for this is that Web of Science, the database we use for this publication analysis, cannot retrieve microbiology papers from multidisciplinary journals. For the most-cited authors' ranking, this limitation did not apply.

Compared to an earlier publication analysis of microbiology (*LT* 1-2011), Germany swapped places with England to become Europe's new number one in microbiology research. Apart from this "change in leadership", most nations have kept their positions. A special mention is deserved for Ireland's excellent standing in 13th place (we will later see why) and Portugal (14th), which climbed four places since the 2011 ranking. When it comes to the citations-per-article ratio, it's striking that almost all nations did equally well, which could suggest that international collaboration is widespread among the microbiology community. Scotland achieved the highest value, with, on average, 33.3 citations per paper; followed by Switzerland and Wales (21st according to total citations).

On the global scale, European microbiologists wrote almost twice as many papers as their US peers, who, however, did not gather twice as many citations. China has obviously intensified their microbiology efforts. Several years ago, they were far behind Japan's, Canada's, Australia's and even Brazil's research output. Now, they have overtaken them all.

Famous papers and a global threat

This brings us to the discipline's top papers published between 2007 and 2013. Spot number one is taken by a rather famous paper: "Enterotypes of the human gut microbiome". Greeted with lots of media fanfare at the time of publication, it proposed that humans host one of only three types of microbial clusters, characterised by a dominant bacterial species. Later, it turned out that the distinct clusters are not that clear cut. The second most-cited paper is about the matrix, the biofilm matrix. In this review, Hans-Curt Flemming and Jost Wingender from the University of Duisburg-Essen, Germany, compile all knowledge about functions, properties and constituents of the self-produced matrix, which provides certain microorganisms with protection, adhesion and nutrition. Antibiotic resistant bacteria are the topic of the third and fourth most-cited papers. In "Emergence of a new antibiotic resistance mechanism", scientists identify Gram-negative Enterobacteriaceae with resistance to carbapenem conferred by New Delhi metallo-beta-lactamase 1 (NDM-1) as a potential major global health threat. Paper number 5 takes us back to the gut. Here, researchers discovered an anti-inflammatory bacterium in Crohn disease patients, which could be used as a probiotic treatment option.

Now, finally, we arrived at the most-cited microbiologists in Europe. First, a few words about our inclusion/exclusion criteria. Because they have their own publication analyses, we decided to exclude all scientists working with viruses or fungi. For the same reason, we also excluded those scientists, who put their focus on

infectious diseases, vaccines or metabolism and nutrition. Thus, our microbiologists' main interest has to be bacteria.

Surveying our top 30, we notice scientists from not less than ten different nations – an unusually high number. England hosts the most highly-cited microbiologists, followed by The Netherlands (especially the University of Wageningen). Three highly-cited microbiologists are each affiliated with institutes in France, Belgium, Germany and Ireland. Interestingly, all three Irish microbiologists work at the University College Cork. Even more interestingly or perhaps astonishingly, there's only one woman among Europe's microbiology elite, *Listeria* expert Pascal Cossart in 15th place.

Pathogenic vs beneficial bugs

But who's number one? Just as with the 2011 publication analysis, it's "l'Indiana Jones des microbes", Didier Raoult. In only seven years, he (somehow) managed to write (be co-author of) more than 600 (!) papers. Everyone can now calculate how many papers these are per week. Raoult's main focus are pathogenic bacteria, such as *Rickettsia* and *Bartonella*; he's also credited with discovering close to one hundred new microbes, including some strange giant viruses. As a side note, two bacteria, *Raoultella planticola* and *Rickettsia raoultii*, are named after him.

Also, a few other microbiologists spend their working time with pathogenic bacteria. Taking a genetics/genomics approach are, for instance, Julian Parkhill (2nd), Gordon Dougan (10th), Nicholas Thomson (23rd) and Stephen Bentley (25th) – all researchers at the Wellcome Trust Sanger Institute, Hinxton. Patrice Nordmann (3rd) together with Laurent Poirel (8th) tackle antibiotic resistant bacteria. Joining them are David Livermore (9th), Neil Woodford (20th), Yehuda Carmeli (24th) and Christian Giske (26th). Pathogens *Salmonella typhimurium* and *Listeria monocytogenes* serve Jörg Vogel (13th) and Pascal Cossart (15th) as models to reveal gene regulation by non-coding RNA molecules and the molecular basis of intracellular parasitism, respectively.

Other highly-cited microbiologists prefer the good over the bad bugs – many of them are found in our gut. Focussing not on single prokaryotes but on the entirety of microbes, the gut microbiome, and how they influence our health and disease are, for instance, Willem de Vos (4th), Joel Doré (6th), Paul Ross (11th), Fredrick Bäckhed (19th) and Michiel Kleerebezem (27th).

Then, there are two more categories: applied microbiology and microbial ecology. As applied microbiologists, Willy Verstraete (5th) and frequent co-author Nico Boon (14th) test bacteria's potential, amongst others, in energy production (microbial fuel cells), wastewater treatment and bioremediation of soils and sediments. Verstraete also has some other, more delicious projects. In one study, he investigated whether chocolate can be used as a carrier for oral delivery of probiotic bacteria and found it to be an "excellent solution". On the ecological front, Frank Oliver Glöckner (12th), Mike Jetten (16th) and Marcel Kuypers (30th) analyse the diversity of marine bacteria, elucidate the role of new (anaerobic) micro-organisms in global element cycles and survey microbial processes that control oceanic nutrient cycling, respectively.

There's hardly a scientific discipline, in which so many things are unexplored. The latest estimates say that about 10^{12} microbial species inhabit our planet. And only a fraction of these species has, to-date, been properly cultivated and described. Time and technology is ripe to shed some more light on this microbial dark matter.

Kathleen Gransalke

Europe...

Country	Citations	Articles	Cit./Art.
1. Germany	232,218	8,528	27.2
2. England	185,310	6,214	29.8
3. France	183,940	6,849	26.9
4. Spain	116,425	5,596	20.8
5. Netherlands	99,977	3,284	30.4
6. Italy	78,296	3,773	20.8
7. Switzerland	65,213	2,075	31.4
8. Belgium	58,403	2,180	26.8
9. Sweden	57,314	2,059	27.8
10. Denmark	46,660	1,786	26.1
11. Scotland	46,042	1,382	33.3
12. Austria	35,753	1,312	27.3
13. Ireland	34,822	1,221	28.5
14. Portugal	24,887	1,200	20.7
15. Israel	24,673	957	25.8
16. Finland	22,367	966	23.2
17. Norway	21,184	883	24.0
18. Russia	20,052	2,073	9.7
19. Czech Rep.	17,909	933	19.2
20. Greece	17,204	739	23.3

Articles appearing between 2007 and 2013 in 'Microbiology' journals as listed by *SCImago* and Thomson Reuters' *Web of Science*. The citation numbers are accurate as of February 2017. A country's figures are derived from articles, where at least one author working in the respective European nation is included in the authors' list. Israel is included because it is a member of many European research organisations and programmes (EMBO, FP7 of the EU...).

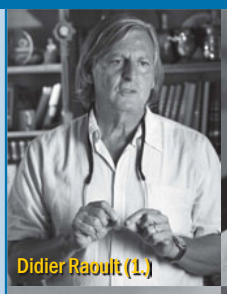
... and the World

	Citations	Articles	Cit./Art.
Europe	1,060,434	46,854	22.6
USA	805,754	27,459	29.3
China	119,588	9,049	13.2
Canada	113,137	4,504	25.1
Japan	104,423	6,428	16.3
Australia	79,137	2,969	26.7
South Korea	66,153	4,910	13.5

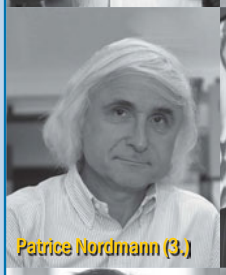
Publication Analysis 2007-2013 – **Microbiology**

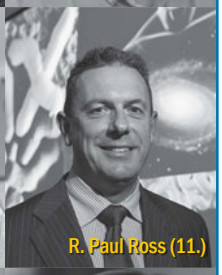
Most Cited Authors...

		Citations	Articles
1.	**Didier Raoult,** Malad Infect & Trop Emergentes, Univ Aix Marseille	18,128	636
2.	**Julian Parkhill,** Wellcome Trust Sanger Inst, Hinxton	17,412	165
3.	**Patrice Nordmann,** Med, Univ Fribourg	12,966	228
4.	**Willem M. de Vos,** Microbiol, Univ Wageningen	12,836	175
5.	**Willy Verstraete,** Microbial Ecol & Technol, Univ Ghent (emerit.)	10,571	231
6.	**Joël Doré,** INRA, Jouy En Josas	10,390	71
7.	**Jeroen Raes,** VIB-KU Leuven Ctr Microbiol, Leuven	9,892	39
8.	**Laurent Poirel,** Med, Univ Fribourg	9,723	161
9.	**David M. Livermore,** Norwich Med Sch, Univ E Anglia, Norfolk	8,776	130
10.	**Gordon Dougan,** Wellcome Trust Sanger Inst, Hinxton	8,702	126
11.	**R. Paul Ross,** Alimentary Pharmabiot Ctr, Univ Coll Cork	8,653	229
12.	**Frank Oliver Glöckner,** Max Planck Inst Marine Microbiol, Bremen	7,565	60
13.	**Jörg Vogel,** Inst Mol Infect Biol, Univ Würzburg	7,441	74
14.	**Nico Boon,** Microbial Ecol & Technol, Univ Ghent	7,393	202
15.	**Pascal Cossart,** Inst Pasteur, Intract Bacteries Cellules, Paris	7,257	114
16.	**Mike S. M. Jetten,** Microbiol, Radboud Univ Nijmegen	7,215	138
17.	**Ed J. Kuijper,** Med Microbiol, Univ Leiden	7,205	111
18.	**S. Dusko Ehrlich,** Mucosal & Salivary Biol, King's Coll London	7,058	36
19.	**Fredrik Bäckhed,** Mol & Clin Med, Univ Gothenburg	6,994	45
20.	**Neil Woodford,** Publ Hlth England, London	6,886	98
21.	**Colin Hill,** Microbiol, Univ Coll Cork	6,594	176
22.	**Niels Høiby,** Immunol & Microbiol, Univ Copenhagen	6,226	117
23.	**Nicholas R. Thomson,** Wellcome Trust Inst, Hinxton	6,168	81
24.	**Yehuda Carmeli,** Epidemiol, Tel Aviv Univ	6,015	96
25.	**Stephen D. Bentley,** Wellcome Trust Sanger Inst, Hinxton	5,853	79
26.	**Christian G. Giske,** Clin Microbiol, Karolinska Inst, Stockholm	5,676	62
27.	**Michiel Kleerebezem,** Anim Sci, Univ Wageningen	5,658	106
28.	**Erwin G. Zoetendal,** Microbiol, Univ Wageningen	5,603	37
29.	**Gerald F. Fitzgerald,** Microbiol, Univ Coll Cork	5,502	113
30.	**Marcel M. M. Kuypers,** Max Planck Inst Marine Microbiol, Bremen	5,492	71


Didier Raoult (1.)


Julian Parkhill (2.)

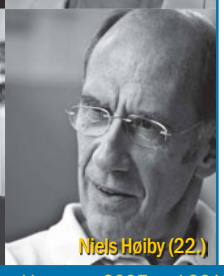

Patrice Nordmann (3.)


R. Paul Ross (11.)


Frank O. Glöckner (12.)


Pascal Cossart (15.)


Mike Jetten (16.)


Niels Høiby (22.)

Citations of articles published between 2007 and 2013 were recorded up until Feb. 2017 using the *Web of Science* database from Thomson Reuters. The "most-cited papers" had correspondence addresses in Europe or Israel.

... and Papers

	Citations
1. Arumugam, M; Raes, J; Pelletier, E [...] [3] Weissenbach, J; Ehrlich, SD; Bork, P Enterotypes of the human gut microbiome. *NATURE 473(7346): 174-180 MAY 12 2011*	1,622
2. Flemming, HC; Wingender, J The biofilm matrix. *NATURE REVIEWS MICROBIOLOGY 8(9): 623-633 SEP 2010*	1,570
3. Kumarasamy, KK; Toleman, MA; Walsh, TR [...] Welfare, W; Livermore, DM; Woodford, N Emergence of a new antibiotic resist. mechanism in India, Pakistan, and the UK: a molecular, biological, and epidemiol. study. *LANCET INFECTIOUS DISEASES 10(9): 597-602 SEP 2010*	1,274
4. Magiorakos, AP; Srinivasan, A; Carey, RB [...] Vatopoulos, A; Weber, JT; Monnet, DL An international expert proposal for interim standard definitions for acquired resistance. *CLINICAL MICROBIOLOGY AND INFECTION 18(3): 268-281 MAR 2012*	1,192
5. Sokol, H; Pigneur, B; Watterlot, L [...] Marteau, P; Seksik, P; Langella, P *F. prausnitzii* is an anti-inflammatory commensal bacterium identified by gut microbiota analysis of Crohn disease patients. *PNAS 105(43): 16731-16736 OCT 28 2008*	1,126