

Publication Analysis 1996-2006

Physiology

The UK dominated European physiology by overall numbers. The highest citation-per-article ratio, however, was achieved by The Netherlands. The most-cited researcher, in fact, worked at the intersection of several disciplines.

It is always worth one's while to follow a trail back to its roots. So first of all, let's take a brief trip through the genesis of modern experimental physiology and its founders.

Philosophical enquiries into the vital functions of animals and plants are, of course, as old as modern mankind itself. Take, for example, Aristotle's reasoning about the relationship between structure and function. The first person, however, to reportedly use experiments to probe the function of the body, was Claudius Galenus (26-199), known as Galen.

The Persian polymath Avicenna (980-1037) in his 14-volume Arabic medical encyclopaedia "The Canon of Medicine" first introduced experimentation and quantification into the study of physiology. However, it was another Muslim polymath, Ibn al-Nafis (1213-1288), who today is regarded as the greatest physiologist of the Middle Ages. In particular, his descriptions, mainly of the pulmonary circulation, gained Ibn al-Nafis the reputation of being the father of circulatory physiology.

Ibn al-Hafis' work, however, has long been ignored in Europe. For this reason, many credit William Harvey (1578-1657) as being the first to correctly describe, in detail, the systemic circulation. In fact, Harvey was the first to include controlled experiments in animals in order to understand the mechanisms of circulation, as well as to obtain quantitative data such as the total volume of blood moved by the heart in a day.

Famous frog experiments

Many experts view the two Frenchmen Claude Bernard (1813-1878) and his mentor François Magendie (1773-1855) as the founders of experimental physiology as a discipline. Bernard, in particular, developed from his rigorous experimental work the concept of the internal environment of the body. With the sentence "constancy of the internal environment is the condition for a free and independent life" he had already expressed the principle of homeostasis. The term homeostasis itself, however, wasn't coined until later by the American physiologist Walter Cannon (1871-1945) in his book "The Wisdom of the Body" (1932).

Magendie and Bernard were also active in shaping the sub-discipline of neurophysiology. Many, however, claim that the true

basis for the systematic study of neurophysiology was laid by Albrecht von Haller's (1708-1777) experiments on irritability and sensibility of nerves and muscles, Luigi Galvani's (1737-1798) discovery of the electrical nature of the nerve-muscle function in his famous frog experiments, as well as Emil-Heinrich Du Bois-Reymond's (1818-1896) first description of an action potential.

How is physiology defined today? The Physiological Society in the UK, for example, describes it as "the study of how living organisms function. [...] It is distinguished from other biological sciences by its emphasis on [...] how the tissues and organs interact and how the parts are integrated to make up the whole. Physiology is a core science for medicine and other biomedical disciplines."

Still a research discipline?

Is that true? Well, it's definitely true concerning the teaching aspect of biomedicine. Every student of biology or medicine has to learn physiology. As a research discipline, however, physiology has continued to break down into organ-specific subfields more recently. One of the consequences being that physiology researchers have been publishing less and less articles in distinguished physiology journals. Instead, the results of groups working, for example, in cardiovascular physiology increasingly appear in cardiology journals, kidney physiologists write in nephrology journals or neurophysiologists in neuroscience journals.

In addition, people in physiology departments are adopting an increasing number of methods from biochemistry, molecular and cell biology to work on problems that, in a strict sense, likewise belong to other disciplines.

For these reasons, it is far from trivial to obtain accurate numbers for a publication analysis "Physiology". Fortunately, the new open access publication platform "SCImago Journal & Country Rank" (www.scimagojr.com) claims to accomplish exactly that, at least on a whole country level. Thus, we selected the subject category "physiology" in the "Country Indicators" part of the database – and received the results for publication performance 1996-2006 of the European countries in physiology research, as detailed in the blue table.

As in many other biomedical disciplines, the UK outperforms Germany by numbers of publications and citations. Both, however, are far ahead of France, in third place.

Comparatively strong is the performance of the Netherlands, fifth by overall citation numbers. Physiology articles from 1996-2006, including at least one author with a Dutch research address, were cited 20.6 times on average to-date – the highest citation-per-article ratio of all European nations. Apart from Switzerland (20.4), also Belgium (19.5) and Denmark (19.2) achieved surprisingly high average citation rates.

Physiology, or already something different?

Altogether, however, physiology researchers in Europe (including Israel) have to make way for their US colleagues. These colleagues published more articles between 1996 and 2006, they have been cited more often to-date and they finally achieved a clearly higher average citation rate (yellow table).

The five most-cited papers of the years 1996-2006 with a correspondence address in Europe (see yellow table next page) again demonstrate how far physiology research has already intermingled with other disciplines. The most-cited paper about the

Europe...			
Country	Citations	Articles	Cit./Art.
1. UK	213,464	11,951	18.2
2. Germany	199,322	10,711	19.1
3. France	115,693	7,760	15.0
4. Italy	91,459	5,484	18.0
5. Netherlands	79,290	4,094	20.6
6. Sweden	57,620	3,588	15.8
7. Denmark	50,367	2,778	19.2
8. Switzerland	49,504	2,601	20.4
9. Belgium	40,759	2,212	19.5
10. Spain	38,517	3,020	13.3
11. Israel	28,378	1,881	15.0
12. Finland	27,661	1,503	18.3
13. Austria	15,833	1,086	15.8
14. Norway	15,583	1,153	14.4
15. Poland	11,215	1,728	7.4
16. Hungary	8,440	881	10.0
17. Czech Rep.	7,538	1,030	7.8
18. Russia	7,477	2,578	3.2
19. Ireland	6,036	393	17.0
20. Greece	5,700	590	11.8

Articles appeared between 1996 and 2006 in journals as listed by Scopus. Numbers for articles and citations were taken from the portal *SCImago Journal & Country Rank* (www.scimagojr.com) applying the subcategory “physiology”. A country's figures are derived from articles where at least one author working in the respective European nation is included in the author's list. Israel is included because it is a member of many European research organisations (EMBO, FEBS etc.) and programmes (FP7 of the EU,...).

... and the world

	Citations	Articles	Cit./Art.
Europe	1,042,701	65,634	15.9
USA	1,352,587	68,773	20.2
Japan	193,881	16,789	11.7
Canada	178,440	11,055	16.5
Australia	79,099	5,773	14.0
China	10,705	3,161	4.6

control of blood vessel development could also be listed under cell or developmental biology as well as under vascular biology. Similarly, the following studies each cross borders deep into cancer research, biochemistry or neurology.

In an analogous manner, the research portfolio of the most-cited researcher 1996-2006, Werner Risau, would fit more into biomedical disciplines than “only” physiology. His work on the mechanisms of angiogenesis is placed perfectly at the intersection of physiology, cell biology and developmental biology with additional relevance to cancer, brain and cardiovascular research. At least, Risau was working at an institute with a long research tradition in cardiovascular physiology, the Max Planck-Institute for Physiological and Clinical Research in Bad Nauheim, Germany. (Risau passed away much too soon at the end of 1998. The last paper with him as co-author appeared in 2004.)

Intersections and overlaps

Similarly, Jens J. Holst from the Panum Institute in Copenhagen, in second place, works in the overlap zone between physiology, endocrinology and diabetology. Thomas Lüscher in third place, is leading a physiology group at the University of Zurich, while at the same time being Head of Cardiology at the University Hospital.

Altogether, the “top 30” list of the most-cited European physiology researchers is dominated by twelve neurophysiologists. Of these, Bert Sakman, who shared the Nobel Prize in 1991 with Erwin Neher (18th) for the development of the patch clamp technique, ranks highest in 8th place.

Also notable is the presence of four Italian neurophysiologists – Giaconda Rizzolatti (11th), Vittorio Galese (20th), Luciano Fadiga (27th) and Leonardo Fogassi (28th) – who were all involved in identifying the so-called mirror neurons in primates, which fire both when an animal acts and when the animal observes the same action performed by another animal.

Apart from the neurophysiologists, the “top 30” list includes four cardiovascular researchers, four kidney specialists, four people working on the physiology of membrane channels and three muscle physiologists.

The only “non-medical” researcher in the list is John Sumpter in 5th place. He was among the first to show that effluents from sewage treatment works, which contain oestrogenic chemicals, cause intersexuality in fish and thereby pioneered the field of endocrine disruption. This, finally, is another example of how physiology effectively intermingles with other disciplines – in this case endocrinology and eco-toxicology.

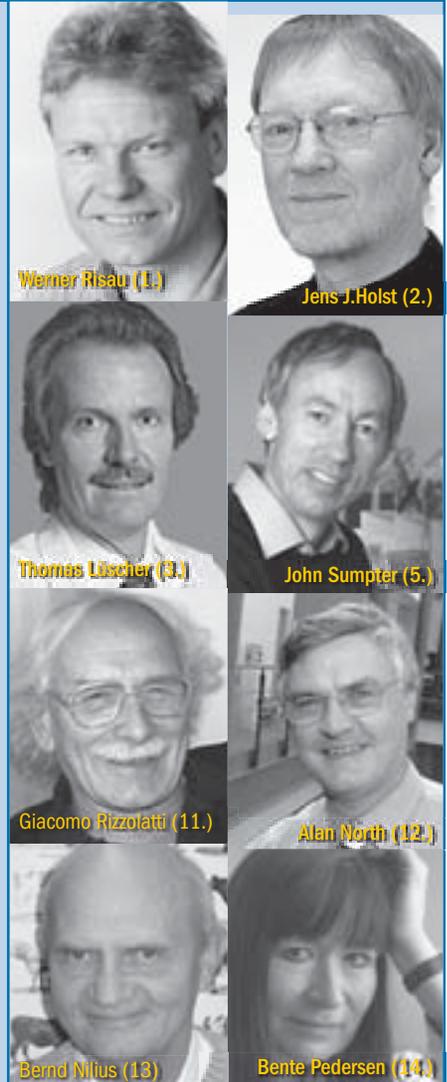
RALF NEUMANN



Publication Analysis 1996-2006 – Physiology

Most Cited Authors...

	Citations	Articles
1. Werner Risau (†1998), Max Planck-Inst. Physiol. Bad Nauheim	11,120	67
2. Jens J. Holst , Med. Physiol. Panum Inst. Univ. Copenhagen	10,888	332
3. Thomas F. Lüscher , Cardiovasc. Res. Inst. Physiol. Univ. Zürich	10,491	280
4. Florian Lang , Physiol. Univ. Tübingen	10,183	357
5. John P. Sumpter , Fish Physiol. Res. Grp. Brunel Univ. Uxbridge/UK	9,213	93
6. Rudi Busse (†2007), Cardiovasc. Physiol. Univ. Frankfurt	9,152	138
7. Søren Nielsen , Water and Salt Res. Ctr. Univ. Aarhus	8,514	269
8. Bert Sakmann , Max Planck-Inst. Med. Res. Heidelberg	7,732	92
9. Thomas J. Jentsch , Leibniz-Inst. f. Mol. Pharmakol. Berlin	7,466	92
10. John C. Rothwell , MRC Human Movement & Balance Unit London	7,417	234
11. Giacomo Rizzolatti , Human Physiol. Univ. Parma	7,324	51
12. R. Alan North , Neurophysiol. Univ. Manchester	7,166	82
13. Bernd Nilius , Physiol. Univ. Louvain	7,064	172
14. Bente K. Pedersen , Muscle Res. Ctr. Copenhagen	6,488	214
15. Wolfram Schultz , Dep. Physiol., Dev. & Neurosci. Univ. Cambridge	5,845	43
16. Guy Droogmans , Physiol. Univ. Louvain	5,596	115
17. Max Gassmann , Vet. Physiol. Univ. Zurich	5,507	130
18. Erwin Neher , Max Planck-Inst. biophysica Chem. Göttingen	5,479	87
19. Wolfgang Schaper , Max Planck-Inst. Physiol. Bad Nauheim	4,877	133
20. Vittorio Galese , Human Physiol. Univ. Parma	4,682	49
21. Roland H. Wenger , Physiol. Univ. Zürich	4,484	73
22. Heini Murer , Physiol. Univ. Zürich	4,195	179
23. Bernhard Bettler , Physiol. Univ. Basel	4,071	66
24. René J.M. Bindels , Physiol. Ctr. Mol. Life Sci. Univ. Nijmegen	3,899	124
25. Thomas Voets , Physiol. Univ. Louvain	3,767	66
26. Jürg Biber , Physiol. Univ. Zürich	3,749	152
27. Luciano Fadiga , Human Physiol. Univ. Ferrara	3,667	35
28. Leonardo Fogassi , Human Physiol. Univ. Parma	3,653	34
29. Jürgen Hescheler , Neurophysiol. Univ. Köln	3,614	149
30. James W. Fawcett , Physiol. Lab Univ. Cambridge	3,578	69



Citations of articles published between 1996 and 2006 were recorded until February 2008 using the database "Web of Science" of Thomson Scientific. The "most cited papers" had correspondence addresses in Europe or Israel.

... and Papers

	Citations
1. Carmeliet, P; Ferreira, V; Breier, G; ...; Risau, W; Nagy, A Abnormal blood vessel development and lethality in embryos lacking a single VEGF allele. <i>NATURE</i> , 380 (6573): 435-439 APR 4 1996	1,620
2. Dimmeler, S; Fleming, I; Fisslthaler, B; Hermann, C; Busse, R; Zeiher, AM Activation of nitric oxide synthase in endothelial cells by Akt-dependent phosphorylation. <i>NATURE</i> , 399 (6736): 601-605 JUN 10 1999	1,101
3. Höckel, M; Schlenger, K; Aral, B; Mitze, M; Schaffer, U; Vaupel, P Association between tumor hypoxia and malignant progression in advanced cancer of the uterine cervix. <i>CANCER RESEARCH</i> , 56 (19): 4509-4515 OCT 1 1996	724
4. Boss, O; Samec, S; PaoloniGiacobino, A; Rossier, C; Dulloo, A; Seydoux, J; Muzzin, P; Giacobino, JP Uncoupling protein-3: A new member of the mitochondrial carrier family with tissue-specific expression. <i>FEBS LETTERS</i> , 408 (1): 39-42 MAY 12 1997	713
5. Gallese, V; Fadiga, L; Fogassi, L; Rizzolatti, G Action recognition in the premotor cortex. <i>BRAIN</i> , 119: 593-609 Part 2 APR 1996	618