



# The New Nutrition Science project

Geoffrey Cannon<sup>1</sup> and Claus Leitzmann<sup>2</sup>

<sup>1</sup>World Health Policy Forum, Juiz de Fora, Minas Gerais, Brazil; <sup>2</sup>Institute of Nutrition Science, Justus Liebig University, Giessen, Germany

## Abstract

The New Nutrition Science project is the result of confluent thinking, especially within the past 10 years. It is a joint Initiative of the International Union of Nutritional Sciences and the World Health Policy Forum. It gives nutrition science, with its expression in food and nutrition policy, a new conceptual framework, a new definition, three dimensions and extended principles. The objective of the New Nutrition Science project is to enable nutrition science to gain all possible relevance in the circumstances of the twenty-first century. It remains work in progress. As expressed in the Giessen Declaration, the result of a workshop meeting held at the University of Giessen, the three dimensions of the new nutrition science are biological, social and environmental. Its concerns are personal, population, and planetary health and welfare. The broad conceptual framework of the New Nutrition Science project looks forward, and also marks a return to the days when nutrition science, and its predecessor discipline dietetics, had most salutary impact on public health. It takes into account the most pressing concerns that face us now, including a continued rising human population, the persistence of malnutrition, the rise of obesity and diabetes in early life, increased inequality within and between nations and populations, rapid changes in global and local food supplies, and the diminution and draining of natural resources. It is only by combining biological, social and environmental approaches that nutrition science can fulfil its potential to preserve, maintain, develop and sustain life on earth.

**Keywords:** *conceptual framework of nutrition; definition of nutrition; dimensions of nutrition; Giessen Declaration; principles of nutrition; three-dimensional nutrition science*

Received: 3 Feb. 2006; Accepted: 8 Feb. 2006

## Introduction

We are living in a world in revolution, as manifested by recent and current interrelated electronic and genomic discoveries and linked and sequential demographic, nutritional and epidemiological shifts, taking place in the context of associated and interlinked global social, cultural, environmental, economic and political developments. These require all disciplines, including that of nutrition science, to make comparably radical responses, in order to work well in the world now.

The general proposal of the New Nutrition Science project is that the world now has been transformed from that mapped by nineteenth and early twentieth century theories and principles. As from the last decades of the twentieth century, the linked political, financial and electronic revolutions known as “globalization”, together with scientific and biotechnological discoveries, and demographic,

nutritional and epidemiological trends, together make a new world that needs new maps (1–4).

It follows that in common with other disciplines, nutrition science needs a new conceptual framework, so as to be able to analyse and assess all relevant determinants of well-being, health and disease, and to take effective action.

As expressed in the Giessen Declaration, the main text of which is printed below with some commentary, the new nutrition science will follow ethical and ecological principles, respect history, tradition and culture, affirm human rights, and be committed to the creation and maintenance of policies and programmes designed to preserve and maintain the human, living and physical worlds.

## Responses and reactions

Since the first publication of the New Nutrition Science project, the editorial and letters pages of

recent issues of the international journal *Public Health Nutrition* have included many references to and comments on the project, both in general (5) and as advocated in the Giessen Declaration (6).

Thus, John Waterlow, emeritus Professor of Nutrition at the London School of Hygiene and Tropical Medicine, while emphasizing the importance of physiology and biochemistry, writes: “The Giessen Declaration has reminded us that environmental science should be included in nutrition’s field of interest” (7).

Marion Nestle, Professor of Nutrition at New York University, writes: “Expanding the definition of nutrition science to encompass social, economic, political and environmental dimensions is a really good idea, especially now that nutrition problems are so universal and so complex... This Project should be required reading for everyone who investigates or applies nutrition science” (8).

Lois Englberger writes from Pohnpei in Micronesia, where she is a collaborator with the International Union of Nutritional Sciences (IUNS) task force on indigenous people’s food systems and nutrition: “I am now promoting the new nutrition science and its findings and recommendations here with members of our island community” (9). Harriet Kuhnlein, convenor of this IUNS task force and Director of the Center for Indigenous Peoples’ Nutrition and Environment at McGill University in Québec, writes: “The New Nutrition Science project holds much promise to develop our thinking... about the issues of people living at the ‘grass roots’ in the real world of global environmental and economic, and hence nutritional, change” (10). From the Globalism Institute in Melbourne, Australia, Gyorgy Scrinis writes: “The New Nutrition Science project rightly emphasizes the need to integrate cultural and ecological dimensions with biochemistry” (11).

Derek Yach, then of the School of Public Health at Yale University, now at the Rockefeller Foundation in New York City, and others, report on a workshop on the future of nutrition involving key stakeholders including industry, held on the occasion of the 18th International Congress of Nutrition in Durban in September 2005. In referring to the New Nutrition Science project, they write: “The International Union of Nutritional Sciences has taken the lead in a project aimed at redefining and broadening nutrition science and practice to include biological, social and environmental dimensions in

an attempt to address nutritional problems in a way that will balance the health of humans and of the biosphere” (12).

Arne Oshaug, Professor of Public Nutrition at Akershus University College in Norway, is, however, not happy. In concluding a long critical commentary he writes: “The New Nutrition Science project... raises a number of challenges of great importance for the further development of public (health) nutrition... [however]... Can it be called ‘a new nutrition science’...? My personal opinion is no” (13). A contrasting view is taken by Professor Thomas Baranowski of Baylor College of Medicine in Texas, USA, who says, with reference to the Giessen Declaration: “Nutritional science, the discipline, is in the midst of revolutionary change” (14). And writing in the UK Nutrition Society Gazette, Esté Vorster, chair of the Durban congress, and a signatory of the Giessen Declaration, says of the New Nutrition Society project: “Scientists are rethinking and reformulating the definition, dimensions and scope of nutrition science, in order to be able to address global nutrition problems in a more sustainable, environmentally friendly and relevant way” (15).

### **Descriptions and explanations**

So it is in a context of considerable interest that the editor of this journal has invited us to give an account of the New Nutrition Science project, including the Giessen Declaration. As convenors of the workshop meeting at which the Declaration was agreed, editors of the special issue of *Public Health Nutrition* in which the new nutrition science has been outlined (5) and presenters of its work in progress in plenary lectures at the Durban congress (16, 17), we are delighted to do so. We also take the opportunity to salute the change in the title of this journal, with all that this may mean.

The case for the new nutrition science is made by Ricardo Uauy, current president of the IUNS. In his paper contributed to the special issue of *Public Health Nutrition*, he writes: “The chemical and biological sciences have provided a strong base for nutrition and have been essential in establishing nutrition as a science with public health relevance. However, these approaches are clearly insufficient to address the main challenges that confront nutrition science now in the twenty-first century. There is a pressing need to include the social, economic and human rights aspects within an ethical framework,

in order to define future policies that will secure the right to safe and nutritious food for all” (18).

Mark Wahlqvist, the immediate past president of IUNS, in his paper in the same special issue, he writes: “Nutrition science has made giant strides in the last century. But the human population continues to increase; and the global climate is changing, with vast implications. Our science has been good in specific ways, but has ignored and overlooked planetary welfare and thus the basic determinants of human health and well-being. We must now ensure that the practice of our science supports sustainable ecosystems and healthy environments” (19).

### **Origins and confluences**

Ricardo Uauy and Mark Wahlqvist are writing in a general context of a felt need for nutrition science to develop. Towards the end of the twentieth century an increasing number of professionals working in nutrition science, food and nutrition policy, and allied fields, became increasingly concerned to emphasize the public and social aspects and implications of their work.

In this they have been and are acting in the spirit of the originators and champions of the great public health movements of the nineteenth century, such as Rudolf Virchow (20), who insisted on the social responsibilities of scientists and correspondingly campaigned to ensure that the ruling classes of the day accepted the need to institute public works such as closed drains, to protect the health of populations. A substantial number of professionals now describe themselves as public health nutritionists, or more broadly as public nutritionists (21), for such reasons.

During the same period others in the field have seen the need to link nutrition as a biological science with its environmental aspects and implications. Nutrition ecology, and then the discipline of Vollwert-Ernährung (“wholesome nutrition”), became taught at the University of Giessen (22), and Mark Wahlqvist and others began to develop the concept of “econutrition” (23). Comparably integrated approaches to nutrition science and food and nutrition policy had and have also been developed by Nevin Scrimshaw at the Institute of Nutrition of Central America and Panama (INCAP) and then at Massachusetts Institute of Technology; John Waterlow at the London School of Hygiene and Tropical Medicine; Malden Nesheim, Michael

Latham, Cutberto Garza and other leaders at Cornell University; Ibrahim Elmadfa at the University of Vienna; and elsewhere.

### **Meetings and decisions**

Before and at the beginning of his IUNS presidency, Mark Wahlqvist decided to work towards the creation of a conceptual framework for this confluent thinking, teaching and practice. Informal discussions to this end were held at the inaugural meeting of the World Health Policy Forum in Camogli, Italy, in 2000, at a workshop meeting at the Bellagio Rockefeller Center, Lake Como, Italy, in 2001, at the International Congress of Nutrition in Vienna, in 2001; at international conferences in Melbourne and Auckland in 2002; at the World Summit for Sustainable Development in Johannesburg in 2002; at the annual meetings of the UN System Standing Committee on Nutrition in Chennai, India, in 2003, and New York in 2004; and at other venues.

As a result, it was agreed to institute a joint Initiative of the IUNS and the World Health Policy Forum; and the present authors were invited to convene the Initiative, Claus Leitzmann then being treasurer of IUNS and Geoffrey Cannon executive director of the Forum. This joint Initiative continues under the IUNS presidency of Ricardo Uauy.

### **Rationale, dimensions, definition and principles**

The new nutrition science is outlined in the Giessen Declaration (6). This is the product of a 4 day workshop meeting held at Schloss Rauischholzhausen of the Justus Liebig University of Giessen in Germany, in April 2005. In identifying the New Nutrition Science project, all participants emphasized that the Initiative is work in progress. The location has special significance: it was at Giessen that Justus von Liebig developed nutrition science as a biochemical discipline.

After the workshop meeting had been completed and the Declaration agreed, participants moved to the Liebig Museum in the middle of the city, within which the offices and laboratories of the great biochemist are preserved. In the small lecture theatre in which he taught the first generations of his students, who then went on to shape nutrition science in Europe, the USA and all over the world, all participants present read out a section of the Declaration a section at a time, and then all signed it.

As already stated, the new nutrition science is three-dimensional: biological, social and environmental. Consequently, it is concerned with personal, population and planetary health; with the human, living and physical worlds. The basic and pressing reason for this new broad conceptual framework is that the science now needs to confront the opportunities and challenges of the twenty-first century, which in many respects are very different to those of the mid-nineteenth century when the science was created in its modern form, by Justus von Liebig and other practitioners of the science that, as devised by them, became known as biochemistry (24).

The Declaration begins by acknowledging that the meeting was held under the auspices of the President of the University of Giessen, the President of the IUNS and the President of the World Health Policy Forum. The signatories then recognize the work already done by institutions, organizations and individuals in Africa, Asia, Europe and the Americas that are already addressing the issues, challenges and resolutions set out in the Declaration. As well as the teaching and practice undertaken in progressive universities and research centres, these include the convergent thinking of recent pioneers, often working in teams, who have developed public nutrition, nutrition ecology and indeed public health nutrition in its broadest aspects.

### **Biological, social and environmental dimensions**

The main text of the Declaration begins by stating: “Now is the time for the science of nutrition, with its application in food and nutrition policy, to be given a broader definition, additional dimensions and relevant principles, to meet the challenges and opportunities faced by humankind in the twenty-first century.

“As originally conceived and as now usually studied and practised, nutrition is principally a biological science. This classic biological dimension of nutrition science is and will remain central. Descriptively it is concerned with the interactions of food and nutrition with physiologic, metabolic and now also genomic systems, and the effects of these interactions with health and disease. Prescriptively it deals with the nutritional control and prevention of disease and the improvement of health in humans, at all levels from individuals to

populations; and also with animals and plants usually as human resources”.

One concern that has been raised since publication of the Declaration is that the new nutrition science seems to pay less attention to the biological dimension. This is not so. Indeed, the three-dimensional approach will encourage biological scientists working in the field of nutrition, to appreciate the social and environmental meaning and implications of their work, which should increase its value. It is with this in mind that the Declaration goes on to state:

“Those now concerned with the future of the world at all levels from local to global, generally agree that their overriding shared priority is to protect human, living and physical resources all together, in order to enable the long-term sustenance of life on earth and the happiness of humankind. Nutrition science is one vital means to this end. This implies expansion and enlargement of the science, and its identification as a broad, integrative discipline, enabled to identify and address the circumstances, challenges and opportunities of the twenty-first century”.

And so: “The biological dimension should therefore be one of the three dimensions of nutrition science. The other two dimensions are social and environmental”.

### **Personal, population and planetary health**

The Declaration goes on to identify the general context in which the food, agriculture and nutrition sciences were originally devised in the mid-nineteenth century in Europe. “The general social, economic and political context of the science at that time was one of industrial and other material expansion, and so of human, mechanical and technological growth and power, and the consequent exploitation of human, living and physical resources. This was at a time when the global human population was far less numerous and less long-lived than it is now. Further, until relatively recently it has generally been assumed that the world’s living and physical resources were inexhaustible.

“Correspondingly, application of the principles that have explicitly or implicitly governed nutrition science, has created food systems that have greatly contributed to the six-fold increase of the global human population in the last 150 years”. This vast increase has come with a price, which begins to show why nutrition science, with its application in

food and nutrition policy, needs to include the environmental dimension and so not be solely concerned with the human species and animals and plants “in the service of humankind”. “During this time non-renewable energy use, material consumption and waste generation have increased enormously. This has resulted in the depletion of many living and physical resources and changes to ecosystems, and also has heightened the contrast between and within rich and poor regions and countries in access to material and other resources”.

The introductory section of the Declaration then includes the following key statement. “For these and other reasons, the human species has now moved from a time in history when the science of nutrition, and food and nutrition policy, have been principally concerned with personal and population health and with the exploitation, production and consumption of food and associated resources, to a new period. Now all relevant sciences, including that of nutrition, should and will be principally concerned with the cultivation, conservation and sustenance of human, living and physical resources all together; and so with the health of the biosphere”.

Global food systems have been and are being transformed with accelerating speed, as a result of mechanization, urbanization, and now biotechnology and economic globalization. These have had and are having various profound effects, some generally beneficial, others that are troublesome. “Food processing, including refrigeration, has enabled the supply of a wide range of foods across seasons and continents. Food manufacturing, retailing and distribution are now increasingly concentrated in fewer hands. Traditional cuisines are being replaced by new eating patterns framed by new technologies, ways of living and economic structures”. The development of technologies “profoundly affect[s] the relationship between food and the health of people, populations and the planet, and will continue to do so”.

### **The general challenges of this century**

The Declaration begins its central section with a statement on the interrelated, profound and accelerating general ideological, social, technological and environmental changes that shape the world in which we now live. “Nutritional status and resultant human health at all levels from individual and

communal to national and global, are affected by these unprecedented changes”.

The Declaration then makes a summary audit of these changes. “This twenty-first century in many respects shows prospects of opportunity and prosperity for the minority that enjoys stable entitlements including physical and financial security, adequate, nourishing and safe food, safe water supplies, and good education and health.

“The majority is not so fortunate. Most people in the world could in future be better off in some and possibly even most respects than they are now. But they are afflicted and threatened by interrelated deprivations that make social and individual life difficult and sometimes impossible. These include loss of amenities and skills; loss of traditional farming and food cultures; loss of land, property and independence; vulnerability to unemployment, dislocation, and other impoverishments; precipitate urbanization; social, economic and political inequities and turmoil; poor governance, and conflicts and wars of many types.”

After long discussions in and out of formal sessions, all participants in the workshop meeting agreed that nutrition science, with its application in food and nutrition policy, must now face environmental facts and projections. “Many planetary environmental indicators are now deteriorating. These include global climate change and the persistent depletion of stratospheric ozone; the depletion and degradation of topsoil; the accelerated loss of species and of fresh water and sources of energy; and increased use and of persistence of many chemical pollutants. Recent and current modes of food production have made major contributions to such adverse changes.

“If these environmental changes are not arrested, the conditions of the natural world will deteriorate for future generations. The extraordinary significance of these changes is that, for the first time in human experience, the overall size and the economic activity of humankind exceeds the capacity of the planet to supply, replenish and absorb. The biocapacity of the natural world is now beginning to diminish.

“Overall, humankind has enjoyed a century of gains in life expectancy, in average income and in per capita food production”. But: “These have been unevenly shared” Further: “Life expectancy has decreased in the past decade in some countries on most continents, and particularly in sub-Saharan

Africa and the former USSR. Income disparities have increased within and between many countries. Global per capita grain production, which accounts for around half of total world food energy, has declined since the late 1990s.”

And in concluding its overview of the general challenges now facing us, the Declaration states: “These and other changes collectively constitute an imminent global environmental crisis on a scale not previously encountered. Great pressures on various components of the life-support system of our planet are already evident. The resultant environmental and ecosystem changes pose many threats to food systems. To understand and remedy this situation will require extending the scope and collaborative engagement of many scientific disciplines, including nutrition science”.

### **The nutritional challenges of this century**

The Declaration then turns to the challenges that are already very familiar to nutrition scientists. “The science is also faced with other interrelated challenges, also constituting an immense imminent crisis, which are and will remain its central direct concerns.”

Reports published by the United Nations and other authoritative organizations over the decades have summarized the state of the world’s malnutrition, and usually have then gone on to set hopeful targets for improvement. But: “Global food and nutrition insecurity and inadequacy and even chronic hunger have not significantly changed in the last twenty years. These are made worse among the most deprived populations by increased inequity between rich and impoverished nations and populations, most especially in areas of conflict and disaster.

“General and specific nutritional deficiencies increase vulnerability to infectious diseases, especially in women, infants and children. These infections in turn worsen food and nutrition security. Although improved in some parts of the world, nutritional deficiencies and infectious diseases have worsened in many of the more impoverished regions, nations and communities. Diarrhoeal diseases, HIV/AIDS and tuberculosis are examples of diseases crucially affected by nutritional status.”

In the last decade, the new challenge is the great increase in prevalence of chronic diseases in middle- and low-income regions and countries. “New epidemics of obesity, diabetes and other chronic

diseases including cardiovascular and cerebrovascular diseases, bone disease and cancers of various sites, are also now afflicting middle- and low-income countries, populations and communities. These diseases, all of which are related to nutrition, impose an enormous burden on healthcare systems”.

The Declaration proposes that only a broad approach can hope to make a gradual, lasting and sustained change for the better, and this is a principal justification for the conceptual framework of the new nutrition science. “Nutrition science can address these challenges; but can do so successfully only by means of integrated biological, social and environmental approaches. These are also essential if nutrition science is to play its part in addressing the general challenges that now face the human species”.

### **Principles, definition and purpose**

Having set the scene, the Declaration then proposes the principles and the definition of the new nutrition science, as follows.

“All sciences and all organised human activities are and should be guided by general principles. These should enable information and evidence to be translated into relevant, useful, sustainable and beneficial policies and programmes.

“The overall principles that should guide nutrition science are ethical in nature. All principles should also be guided by the philosophies of co-responsibility and sustainability, by the life-course and human rights approaches, and by understanding of evolution, history and ecology.

“Nutrition science is defined as the study of food systems, foods and drinks, and their nutrients and other constituents; and of their interactions within and between all relevant biological, social and environmental systems”.

And then, for the twenty-first century, “The purpose of nutrition science is to contribute to a world in which present and future generations fulfil their human potential, live in the best of health, and develop, sustain and enjoy an increasingly diverse human, living and physical environment.

“Nutrition science should be the basis for food and nutrition policies. These should be designed to identify, create, conserve and protect rational, sustainable and equitable communal, national and global food systems, in order to sustain the health,

well-being and integrity of humankind and also that of the living and physical worlds”.

The conclusion of the Declaration emphasizes the need now for integrated work: “There remains much work to be done in the biological dimension of nutrition science. Much other important work now has to be carried out also in the social and environmental dimensions: this will require a broad, integrated approach. This Declaration emphasizes that the most relevant and urgent work to be done by professionals working in nutrition science and in food and nutrition policy, is in its three biological, social and environmental dimensions all together”.

### Signatories

The nature of the New Nutrition Science project as work in progress is emphasized. The signatories of the Declaration include the immediate past president and the future president of the IUNS; the president and officers of the World Health Policy Forum; the chair of the 18th International Congress of Nutrition at Durban; the editor-in-chief of *Public Health Nutrition*; participants from the Food and Agriculture Organization of the United Nations and the European Bank for Reconstruction and Development; and specialists in nutrition and food and nutrition policy and allied disciplines.

They are Christopher Beaman, Geoffrey Cannon, Ibrahim Elmadfa, Peter Glasauer, Ingrid Hoffmann, Markus Keller, Michael Krawinkel, Tim Lang, Claus Leitzmann, Bernd Lötsch, Barrie Margetts, Tony McMichael, Klaus Meyer-Abich, Ulrich Oltersdorf, Massimo Pettoello-Mantovani, Joan Sabaté, Prakash Shetty, Marco Sória, Uwe Spiekermann, Colin Tudge, Esté Vorster, Mark Wahlqvist and Mariuccia Zerilli-Marimò. Others not present at the Giessen meeting who contributed papers to the special issue of *Public Health Nutrition* which formed the basis for the thinking of the workshop were Micheline Beaudry, Hélène Delisle, Barry Popkin and Ricardo Uauy.

### So, what now?

“Conclusion” is not the correct term for this final section, because the New Nutrition Science project is work in progress and so is beginning.

At the Durban congress, the plenary presentations were followed by a symposium during which the new nutrition science was shown in action, in Germany, Brazil and South Africa. At the symposium

those present were asked whether they were willing and able to help to form new nutrition science networks, and almost 100 responses then and later came from Argentina, Australia, Belgium, Cameroon, Canada, Chile, France, Greece, India, Iran, Italy, Kenya, Micronesia, Morocco, New Zealand, Nigeria, Norway, Senegal, Serbia, South Africa, South Korea, Switzerland, Tanzania, Thailand, the UK, the USA and Zambia.

Immediate plans are to continue to develop the principles of the new nutrition; to establish global networks to develop its thinking and to discover and explore three-dimensional science and policy in action; and to inform, empower and build capacity in the south and among young professionals.

We, who remain the convenors of the Initiative and the project, will be very glad to hear from readers who want to know more, and who want to join in.

### References

1. Castells M. The information age: economy, society and culture. Three volumes, new edn. Oxford: Blackwell; 2000.
2. Diamond J. Collapse. How societies choose to fail or succeed. London: Allen Lane; 2005.
3. Sen A. Development as freedom. New York: Anchor Books; 1999.
4. McMichael A. Human frontiers, environments and disease: past patterns, uncertain futures. Cambridge: Cambridge University Press; 2001.
5. Leitzmann C, Cannon G, eds. The New Nutrition Science project. *Public Health Nutr* 2005; 8(6A): 667–804.
6. The Giessen Declaration. *Public Health Nutr* 2005; 8(6A): 783–6.
7. Waterlow J. *Public Health Nutr* 2005; 9(2): (in press).
8. Nestle M. Comment on New Nutrition Science project (Letter). *Public Health Nutr* 2006; 9(1): 94–95.
9. Englberger L. Indigenous harmony (Letter). *Public Health Nutr* 2006; 9(1): 95.
10. Kuhnlein H. Indigenous harmony (Letter). *Public Health Nutr* 2006; 9(1): 95.
11. Scrinis G. Reducing and integrating (Letter). *Public Health Nutr* 2006; 9(1): 95–96.
12. Yach D, Eloff T, Vorster H, Margetts B. Report of a pre ICN workshop on Negotiating the Future of Nutrition, Johannesburg, South Africa, 18 September 2005. *Public Health Nutr* 2005; 8: 1229–30.
13. Oshaug O. Nutrition and evolution (Letter). *Public Health Nutr* 2006; 9(1): 96–98.
14. Baranowski T. The “new nutrition” and physical activity (Editorial). *Public Health Nutr* 2005; 8: 805–7.
15. Vorster H. The Nutrition Safari in Durban 2005: a wake-up call! *Nutr Soc Gaz* 2005; 28: 5.

16. Leitzmann C, Cannon G. The new nutrition science. Principles. *S Afr J Clin Nutr* 2005; 18: 124–8.
17. Cannon G, Leitzmann C. The new nutrition science. Practice. *S Afr J Clin Nutr* 2005; 18: 130–5.
18. Uauy R. Defining and addressing the nutritional needs of populations. *Public Health Nutr* 2005; 8(6A): 773–80.
19. Wahlqvist M. The new nutrition science: sustainability and development. *Public Health Nutr* 2005; 8(6A): 766–72.
20. Ackerknecht E. Rudolf Virchow – doctor, statesman, anthropologist. Madison, WI: University of Wisconsin Press; 1953.
21. Beaudry M, Delisle H. Public(s) nutrition. *Public Health Nutr* 2005; 8(6A): 743–8.
22. Leitzmann C. Wholesome nutrition: a suitable diet for the new nutrition science project. *Public Health Nutr* 2005; 8(6A): 753–9.
23. Wahlqvist M, Specht R. Food variety and biodiversity: econutrition. *Asia Pac J Clin Nutr* 1998; 7: 314–9.
24. Brock W. Justus von Liebig. The chemical gatekeeper. Cambridge: Cambridge University Press; 1997.

---

**Claus Leitzmann**

Institute of Nutrition Science  
Justus Liebig University  
Wilhelmstrasse 20  
D-35392 Giessen  
Germany  
Tel.: +49 6405 7614  
Fax: +49 6405 502899  
E-mail: Claus.Leitzmann@ernaehrung.uni-giessen.de