Commentary

Food and nutrition science: The new paradigm

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Nutrition was invented in the early 19th century as a biochemical science that reduces foods into significant chemical constituents. Ever since then, the teaching and practice of nutrition has been based on this conceptual framework, or paradigm. The examples given here are dietary guidelines and other food guides. The first guides issued up to the middle of the last century were designed to help prevent nutrient deficiencies, promote growth, and ensure plentiful diets. These recommended foods then thought to contain adequate proteins, fats, carbohydrates, vitamins, minerals and trace elements, as well as dietary energy. At a time of accelerating industrial production of food, they were generally effective. Within the second half of the century, guides were developed and changed to counter the rapid rise in heart disease in the USA, the UK, and other high-income countries. These recommended less foods of all types high in fat, saturated fat, cholesterol and sodium, more 'complex carbohydrates', and fruit and vegetables rich in microconstituents. They probably had some limited effect. In this century and now, dominant guides have been changed again in attempts to counter what has become pandemic obesity and diabetes. These recommend less food high in saturated fat, sugar and sodium, with less emphasis on total fat and more on sugar. They are not effective. All these guides are derived from and governed by the biochemical paradigm of nutrition science. This was once useful, but now should be discarded as obsolete except for addressing deficiencies. Here, a new paradigm is proposed.

Key Words: food and nutrition science, paradigms, The New Nutrition Science, the NOVA food system, Brazilian food guides

INTRODUCTION

This commentary is in seven parts. First, the invention of nutrition as a biochemical science. Then, food guides based on this paradigm issued in the last century and up to date. Then, what paradigms are. Then, the 2005 New Nutrition Science; the NOVA food classification as from 2009; and the 2014 Brazilian food guide. Finally, the proposed paradigm for food and nutrition science is defined, with purposes and principles.

What is the definition and purpose of 'nutrition science'? This often seems vague. A definition in *The Shorter Oxford Dictionary* is: 'The branch of science that deals with (esp. human) nutrients and nutrition', and 'nutritionist' is defined as 'an expert in or student of (esp. human) nutrients and nutrition'. These definitions are practically circular.

The teaching and practice of conventional nutrition science has become dominated by the USA and to a lesser extent the UK and some other industrialised countries, and also since the creation of the United Nations by relevant UN agencies. A standard textbook with 107 authors (all but 6 from North America or Europe),[1] states that 'nutrition is an ever-changing science' but does not define 'nutrition' or state its purpose, which can however be deduced from its 65 chapters within 760 large-format pages. The first 36 have sections on energy physiology; macronutrients; fat-soluble vitamins; water-soluble vitamins; and minerals and trace elements. The other 29 have sections on the life-cycle; physiology and patho-physiology; nutrition and chronic diseases; food, nutrition and pathophysiology; international nutrition, and 'emerging issues' such as biotechnology, functional foods, and the human genome.

While these books do not explicitly state what nutrition science is, or what it does, or why, they make apparent that it is not just a basic science, but is also concerned with health, in the medical sense of preventing and treating various physical human disorders, disabilities and diseases. Its nature is indicated in the preface to another textbook (whose 24 authors are all but 4 from Europe or North America), commissioned by the UK Nutrition Society primarily for students of nutrition. It states: '*The study of human nutrition needs a solid base in the physiology and biochemistry of human metabolism*'.[2] This also does not explain why, or indicate alternatives.

Thus identified, nutrition focuses on nutrients, which is to say some of the very many bioactive chemical constituents within foods, as well as dietary energy. Its main evident practical purpose is to promote adequate

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feeding, and to prevent and treat specified physical conditions of humans believed to be caused by deficient, inadequate, or unbalanced diets. It is not concerned with good health other than absence of ill-health, nor with well-being. As such it is largely an adjunct of the predominant practice of medicine.

With time, nutrition science in this 'classic' form has become more complex, but its general nature remains essentially the same. Its biochemical conceptual framework, which to say paradigm, continues to focus on nutrients and energy, and so continues to govern food guides, the example given here. Guides include dietary guidelines, food composition tables, reports, statements, pamphlets, posters, specifications, and other educational material, published above all by national governments and international and national organisations, periodically as from the early 20th century.

THE MID-19TH CENTURY
THE INVENTION OF NUTRITION SCIENCE

For many centuries, food and its role in health was seen differently. Beginning in Egypt around 4,000 BCE, China around 2500 BCE, and then India, Greece, the Arab world, and Western Europe up until the 18th and early 19th centuries CE, interest in and study and practice of food and health was part of the qualitative natural philosophy of the good life well led, identified in Greece as for example by Plato as *diaita* - dietetics. Taking various forms in different civilisations, dietetics fosters the good health and well-being of all aspects of humans: physical, mental, emotional, moral and spiritual. What, how, when, where and with whom habitually to eat is part of the whole dietetic wise way of living.[3-5]

But in the mid-19th century, dietetics was displaced. Following the work of Antoine-Laurent de Lavoisier, François Magendie, and others, the German chemist Justus von Liebig (1803-1873) narrowed and isolated nutrition as a quantitative biochemical discipline, turning it into a 'hard' science, following the discoveries that food can be reduced into various identified measurable chemical macro- and micro-constituents needed for growth, health and life.[6]

Of these, von Liebig regarded protein as 'the only true nutrient', because it promotes and accelerates growth. He devised artificial 'NPK' fertiliser. He invented the first commercial artificial baby formula based on cows' milk, which is far higher in protein than breastmilk and therefore in his view superior, together with flour of wheat, malt and (later) peas, and potassium bicarbonate, as in effect fertiliser for infants. He developed the first commercial meat extract as a restorative and 'super-food'. He was a successful entrepreneur, and a rough competitor who wrecked the reputations of natural philosophers and other rivals, while gratifying the ruling classes.[7]

With his followers, von Liebig blazoned 'physiological chemistry' as he called it, as essential for plant, animal and human breeding. His vision was that this could harness and master nature, and would engineer the food systems of industrialising countries. He believed that his formulations and his science could transform the human race. His work accelerated the industrial and agricultural revolutions.

Von Liebig's special importance to governments was that high-protein diets bred and sustained big tall strong men fit to endure land wars, then almost incessant within Europe. His importance to industry was that he valorised the production of beef, milk and other dairy products, all high in protein and also fat. With the growth of railways, the invention of disassembly lines,[8] and increased use of freezing, chilling, canning and bottling, these became immense enterprises most of all in the USA, gaining the power to change life on earth, as they have done. Protein of animal origin is still emphasised.[9]

The eclipse of German science as a result of the two world wars made Justus von Liebig internationally less well-known than Louis Pasteur, but his impact on human life has been just as great. His concept of nutrition as a biochemical science is still dominant, as 'classic' nutrition. Until recently it has rarely been questioned inside the nutrition profession.

THE EARLY AND MID-20TH CENTURY
EAT AND DRINK MORE

All sciences meant to be useful, such as nutrition, have contexts and needs, which in time, change. In the early and mid-20th century, up to the 1970s, food guides, designed to generate public policies and actions, and food tables, for use by nutritionists and dietitians, continued to categorise foods in terms of specified chemical constituents. They primarily addressed two contexts and needs critical at that time. One was nutritional deficiencies, inadequacies and imbalances, then and now endemic in the global South, and then also common in low-income families in industrialised countries such as the USA and the UK.[6] The other, as in the 19th century, was war, especially the two world wars and the need to promote population growth and strength, and to survive, work, and fight. Food rationing, introduced in the UK in both world wars, helped to maintain national good health.[10,11]

In this period, food guides were published in the USA, the UK and increasingly in many other countries, and internationally by the League of Nations and then by United Nations agencies. They recommended groups of foods seen to be good sources of dietary energy, protein, carbohydrate, fat, minerals, and as from the 1920s, vitamins.

The concept of types of foods grouped according to their comparative contribution of energy and macro- and micronutrients, pioneered in the late 19th century in the USA by chemist Wilbur Atwater, became a feature of official US food guides throughout the 20th century and to date.[12] A 1917 guide issued by the US Department of Agriculture[13] stated on food selection: *'Perhaps as easy a way as any… is to group the different kinds according to their uses in the body and then to make sure that all the groups are represented regularly in meals… 1. Fruits and vegetables; 2. meats and other protein-rich foods; 3. cereals and other starchy foods; 4. sweets; and 5. fatty foods'*. On sugar, the guide said: 'Unless small amounts of very sweet materials – sugar itself, syrup or honey – are used, the diet is liable to be lacking in it'. The five

food groups, which included sweets and also fatty foods, were retained in USDA publications throughout the 1920s,[14] and the system of foods grouped according to their relative content of specified nutrients has been used ever since.

International food guides were issued by the League of Nations. In 1936 a League report stated specifically of whole (full-fat) cow's milk: *'Milk is the nearest approach we possess to an ideal food…It contains all the materials essential for the growth and maintenance of life… Milk should represent a large proportion of the diet of every age'*.[15] In the UK John Boyd Orr, who became founding director-general of the UN Food and Agriculture Organization in 1946, wrote in 1940 commenting on a 1937 UK Ministry of Health report on nutrition:[16] '*The Advisory Committee on Nutrition … has strongly recommended that every child should have at least 1½ pints of milk a day. The unanimity of the importance of milk is of special interest… It is… rich in first-class protein, minerals, and most of the vitamins*'.[17]

In the UK, national nutrition was supported in 1940 at the beginning of the Second World War by publication of an official report containing tables, with the accurate title *The Chemical Composition of Foods*.[18] Its preface began: '*The nutritional and dietetic treatment of disease, as well as research into problems of human nutrition, demand an exact knowledge of the chemical composition of food*'.

The 1960 edition dropped the word 'chemical' from the title, as have later editions co-published by the Royal Society of Chemistry. These tables are regularly updated and elaborated, and are now greatly expanded, but retain their original form and basic structure. All official tables published to date specify what is seen to be the relevant acknowledged chemical composition of foods. They, and versions compiled in the USA, devised in and for temperate industrialised countries, have been adopted or adapted and developed in other countries and by the UN Food and Agriculture Organization.[19] Among nutritionists and dietitians they have quasi-biblical status.

In 1954 the UK Ministry of Health made further specific recommendations for consumption of whole cow's milk, which because of its protein and fat content remained seen as an ideal food. These were for children and adolescents from 1 to 21, 1 pint a day, expectant mothers 2 pints a day, and all other adults half a pint a day.[20]

Seven editions of the Manual of Nutrition published by the UK Ministry of Food between 1945 and 1970 began by defining carbohydrates, fats and protein, and stated: *'See that the building foods are well represented. Make sure that the protective foods are included. Let appetite determine how much of the energy foods are to be added'*. For children: '*Bread, and particularly cake made with fat, sugar, milk and eggs, are excellent as concentrated sources of calories'*.[21] The focus of the Manual was on home cooking. There was no discussion of industrial food processing.

Three groups of 'body building', 'protective' and 'energy' foods were identified in 'food chart' posters issued by the UK government's Central Office of Information in the 1940s to the 1950s. A wartime poster included a group of 'energy foods', symbolised by a hammer labelled ENERGY that 'provide food for the body', listing sugar, dried fruit, honey, cheese, butter, margarine, dripping, suet, and lard, as well as potatoes, bread, flour, oatmeal, rice, sago, bacon, and ham. The message was: 'eat something from each group every day'.[22]

In the US, guidance from its Department of Agriculture continued to group foods according to their relative contribution of chemical constituents. In 1958 its *Food for Fitness: A Daily Food Guide* grouped the 'Basic Four'. These were a milk group, for protein and fat (2 to 4 cups, depending on age); a meat group,– beef, veal, pork, lamb, poultry, fish, eggs, with as alternatives beans, peas and nuts, also for protein and fat (2 or more servings); a vegetable/fruit group, for vitamins and minerals (4 or more servings); and a bread/cereal group, wholegrain, fortified or restored, for carbohydrates (four or more servings), 'plus other foods as needed to complete meals and to provide additional food energy and other food values'. The USDA retained versions of the 'Basic Four' for the next 22 years.[12,14]

Up to the 1970s, the general policy of official dietary guidelines in the USA, the UK, and some other industrialised countries, with collaborative policies and actions, especially from the farming and food manufacturing industries, was to address deficiencies and undernutrition by helping to enable the mass of populations to have plenty to eat. This was good news for and so supported by the intensive agriculture and food processing industries and the fast food and soft drink businesses. Emphasis was given to meat, milk, dairy and other animal foods and products, good sources of protein and fat as 'building foods'; and to cereals, cereal products, other starchy foods, and sugar and sugary foods, good sources of carbohydrate and dietary energy, as 'energy foods'; and fruits and vegetables, good sources of vitamins and minerals, as 'protective foods'.

Food guides published up to the 1970s generally addressed 'home-makers'. The nutrition scientists responsible for food guides were quite often funded by or advisors to industry, or employed by industry before, at the time or later, as they are now. In any case, they usually seemed to have no special knowledge of food technology and processing, or agriculture, or the preparation and cooking of meals, or of dietary patterns, or of food culture. Their main attention was on the known and recognised chemical components of whole foods. Problems included the inconvenient fact that dishes and foods as for example pies, stews and sausages, and biscuits, cakes and ice-cream, contain combinations of protein, carbohydrate and/or fat, and that the contents of meals cannot be readily quantified. The guides paid little attention to food eaten out of the home, despite the rise of fast food and drink outlets at first in the US.[23] They also generally ignored processing other than freezing, chilling, fermenting, canning and bottling, despite the increased and extensive use of technological processes such as hydrolysis, extrusion, and partial hydrogenation of oils in the manufacture of margarine and many commercial baked goods. Food additives, then and now were omitted, and thought to be only of toxicological concern.

Compliance with the recommendations of these guides often helped to reduce rates of deficiency and under-nutrition in many countries.[24] In the USA, UK and other high-income countries, national incentives and subsidies given to the intensive agriculture and food manufacturing industries helped to develop food systems and supplies. On the whole, the guides issued up to the later 20th century were evidently valuable.

THE LATER 20TH CENTURY

EAT AND DRINK LESS

Later and roughly into the late 1980s and early 1990s, food guides issued in the USA, the UK, other high-income countries, and by UN agencies, altered the findings of previous guides. The emphasis became not so much on recommending more food seen as healthy, as on less food seen as unhealthy.[25] This was bad news for and so opposed by the intensive agriculture businesses and the leading food processing and fast food and soft drink industries, which as from the 1980s became increasingly transnational. They developed and strengthened their front, representative and associated organisations.[26]

The main reason for the new emphasis was a new crisis. Heart disease, previously uncommon, had become epidemic in the USA and various fully industrialised countries, and was predicted to become common world-wide. Some attention was given to obesity, prevalence of which was rising notably in these countries. Of 100 such reports published between 1961 and 1991, 93 recommended consuming less fat, 85 less saturated fat, 47 less dietary cholesterol, and 82 less sugar, with few or none disagreeing, and of those that specified food, 51 recommended less fatty meat or meat products, 53 less full-fat milk, 50 less butter and 27 fewer eggs, with few or none disagreeing.[25] Later reports in this period often set quantified targets, such as 10 per cent or less of dietary energy from saturated fat, with implications for all types of food that are sources of saturated fat.[27]

A 1982 report from the World Health Organization,[28] emphasised vegetables, fruits, cereals and beans, as containing 'good quality' protein and as low in fat, saturated fat, sugar, sodium and dietary energy; lean and low-fat meat and dairy products; and less use of oils and fats. Foods to 'de-emphasise' were with two exceptions whole foods: high-fat meats, whole milk, cream, cheese, and eggs, 'commercially baked products' (unspecified), and alcoholic drinks.

These and later guidelines were driven above all by the theories of the US physiologist Ancel Keys of the University of Minnesota, featured on the cover of *Time* magazine in January 1961, whose influence became dominant worldwide in the mid- and later 20th century. His personality was like that of Justus von Liebig: he controlled colleagues, excoriated rivals, and charmed government officials. He led the Seven Countries Study of middle-aged men mostly in rural villages in the USA, Finland, the Netherlands, Italy, Yugoslavia, Greece (Crete and Corfu) and Japan, initially completed in the late 1960s, the largest epidemiological study of its type until then carried out. This confirmed his opinion that the chief dietary cause of cardiovascular disease was diets high in saturated fat and cholesterol, and he convinced his colleagues, professional bodies, and the governments of the USA and then other countries.[29,30] This made nutrition more mystifying outside the nutrition profession, because these substances cannot be seen or sensed.

One response from the intensive agriculture and food processing industries to what had become a worldwide expert consensus, endorsed by governments and relevant UN agencies, was to reformulate many foods and products. Cows and pigs were bred to be less fat. Lower and low-fat milk became more available. Many food products became made in versions lower in fat, but often higher in sugar. Consumption of fat and saturated fat decreased in various industrialised countries.[31]

The recommendations of these guides are generally agreed to have helped to reduce heart disease in the USA, UK and other high-income countries, which was also often successfully treated with drugs and surgery. The prevalence of obesity increased, including in middle-income countries. Preoccupation with heart disease meant that these guides were of little if any use for deficiencies. So the guides issued in the late 20th century were of limited value.

INTO THE 21ST CENTURY

PANDEMIC OBESITY AND DIABETES

As from around the 1990s the priority switched again. The context was and remains in the 2020s the crises of obesity and diabetes. Most conspicuously since the 1980s, prevalence of overweight and obesity had continued to rise in high-income countries and then especially in middle-income countries and even in many low-income countries in Latin America, Asia and Africa, as had prevalence of diabetes. Both still rise; in the highest-income countries obesity may now be reaching a peak at up to or around 30-40% of the adult population.

The *Dietary Guidelines for Americans* (DGA), issued every five years since 1980s, is the national official food guide that is internationally most influential, together with reports from relevant UN agencies. It is published jointly by the US Department of Health and Human Services, and the US Department of Agriculture which is responsible for the US agriculture and also food manufacturing industries. The DGA have never stated or even suggested that these industries are responsible for producing and manufacturing unhealthy food. Their guidance is addressed only to people as consumers.[12]

All editions of the DGA have maintained the biochemical paradigm of 'classic' nutrition science, continuing to group foods in terms of their relative content of the chemical constituents known or thought to affect human physical disorders, disabilities and diseases. They pay little attention to how foods are produced and processed, or to meals, or to dietary patterns. The US government has ruled that sustainability is out of scope.[32] Well-being is largely limited to photographs of people eating and looking happy that accompany the text.

The 2015 DGA, for 2015-2020, specifies in its third guideline: 'Limit calories from added sugars and saturated fats and reduce sodium intake'. The 2020 DGA, for 2020-2025,[33] has been issued when obesity and diabetes have been commonly identified as out-of-control epidemics in the US, and as pandemics. This DGA has

changed only incrementally from previous issues. It has more on meals and some on dietary patterns, but there is still little on how foods are processed. Its fourth guideline is: 'Limit foods and beverages higher in added sugars, saturated fat, and sodium, and limit alcoholic beverages'. Thus sugar (as added sugars) and salt are highlighted as well as saturated fat. The recommendation on cholesterol disappears. The guidance of these and the previous DGAs remain based on dietary energy and various chemical constituents of food.

There is little or no evidence that the DGAs issued since 2000 have improved the health of the US population. Now, there is a crisis of confidence, as evident in the separate report set up by the US government to advise the 2020 DGA. This states: *'The typical American dietary pattern is not currently nor has it ever been aligned with recommendations issued by the Dietary Guidelines for Americans since their inception in 1980'*.[34] Scholars in the USA point out failures of the DGA, or have a broader view.[31,32,35]

CURRENT FOOD GUIDES ARE OBSOLETE

Disquiet concerning the current stance of the US government evident in what its 2020 DGA says and what it omits, is expressed in the separate advisory report, in statements not included in the approved report. One is: *'Burgers and sandwiches, casseroles, pizza, snacks and sweets, and beverages (other than milk and 100% juice) contribute 50-60% of total energy intake. For the total population, the top 5 contributors to energy intakes include burgers and sandwiches; desserts and sweet snacks; rice, pasta and other grain-based dishes; sweetened beverages; and chops, crackers and savory snacks'*.[34] Another is: *'The food… components to limit… consumed in excess… [come from] sweetened beverages… desserts and sweet snacks, candy and sugars, breakfast cereals and bars, burgers and sandwiches, higher fat dairy products, food items that are predominantly fat… and mixed dishes, such as pizza…. Snacking is more prevalent—almost universal'*.[34] Most of these foods, listed but not characterised in the advisory report, are mass-produced, branded, processed and packaged products.

The US DGAs are given here as examples, because of their influence and power. Food guides issued throughout the world continued to follow the biochemical paradigm,[25] including the 1990 UN WHO report on Diet, Nutrition and the Prevention of Chronic Diseases.[27] The most recent 2003 UN WHO/FAO report with the same title has goals expressed as percentages of dietary energy for total fat, saturated fats, polyunsaturated fats, trans-fats, monounsaturated fats, carbohydrate, protein, cholesterol, sodium chloride, dietary fibre, and non-starch polysaccharides, and also fruits and vegetables specified as rich sources of micronutrients and 'bioactive substances'.[36]

In 2011 the WHO set up its Nutrition Guidance Expert Advisory Group (NUGAG), which has issued or is preparing reports on total fat intake and weight gain; saturated fatty acids and trans-fatty acids and cardiovascular disease; polyunsaturated fatty acids; sugars, weight gain and dental caries; non-sugar sweeteners; carbohydrates; sodium and cardiovascular disease, and potassium and cardiovascular disease. Finally, a NUGAG report on healthy dietary patterns seems to be one of those in preparation.[37]

Table 1. Summary
Current food guides are obsolete

Key reasons why, are that they:
-Fail to achieve their stated objectives
-Assume that nutrition is biochemical, quasi-medical
-Reduce foods into separate chemical constituents
-Merge whole foods with processed products
-Use language fully understood only by professionals
-Identify people mainly as individual consumers
-Focus only on some disorders, disabilities, diseases
-Recommend artificial or unrealistic diets
-Neglect or omit fresh meals, families, ways of eating
-Say little about society, economy, the environment
-Isolate humans from the natural and physical worlds
-Ignore technological changes, future generations

Since around the 1990s, food guides in the form of dietary guidelines have virtually all failed in their objectives. In this time obesity and the closely related disease of diabetes have become pandemic, and rates of other diet-related disorders and diseases have increased in many countries.[38]

Table 1 indicates the failings of almost all current food guides. Some are as follows. They have little if any relevance for deficiencies. They often merge fresh foods with processed products. In effect they recommend artificial or unrealistic diets. They pay little attention to dietary patterns and meals. They address food consumption, not production, and people as consumers, not as citizens. They say nothing about the impact of technology as used by corporations to formulate what are now identified as ultra-processed food products. They omit food additives. They are silent on the effect of dietary quality on susceptibility to and severity of infectious diseases, including those caused by coronaviruses. They mostly ignore the social, cultural, economic, political and environmental determinants of food systems and supplies and thus of what people eat and drink. Most have little or nothing to say about food as this relates to and affects the living and physical world and the biosphere.

Additionally, once foods are seen as wholes, it is obviously irrational to identify food with a small number of its over 26,000 chemical constituents.[39] Many of these that are ignored in current food guides are now known to affect human functions and health.

Also, the foods specified in food guides are biased towards those available in temperate countries. Food composition tables may not give values for indigenous tropical plant foods, many not exported and some higher in nutrients than temperate versions,[40] although work on this is being done by the UN Food and Agriculture Organization.[19] Further, they neglect or ignore herbs and spices, commonly added in preparation of meals; while insignificant in dietary energy, many are concentrated sources of bioactive compounds known or thought to protect against diseases or to enhance good health.[41]

Above all, they persist in reducing foods into chemical constituents, and so remain entrenched in the biochemical paradigm of 'classic' nutrition science.

One partial exception is the first Brazilian official national food guide issued in 2005 and in a new edition in 2008.[42] It is written in plain language that any attentive reader can understand. It sets out the principles on which it is based; these include recognition of food culture and the need for environmental sustainability. Its guidelines are for people as citizens and family members, and separately also for government and industry, and for health professionals. Its first five guidelines address healthy meals and foods; grains, roots and tubers; fruits, vegetables and salads; beans; and meat, milk and dairy products and eggs. Information about food constituents is separated in boxed text.

Times, needs and foods have changed. Relevant crises and changing circumstances now include the obesity and diabetes pandemics, economic globalisation, transnational food corporations, the depletion of non-renewable resources, the rapid increase of an ageing and physically bigger world population, increased food insecurity, worldwide pollution, plundered ecosystems, biodiversity collapse, climate disruption, and the Covid-19 pandemic, with its variants. In this age of the Anthropocene,[43] the nature of food systems and supplies has become or is becoming transformed.

Also, nutrition science and therefore food guides need to address good health and well-being as well as disorders, disabilities and diseases; to be concerned with whole human beings, mind, body and spirit; to include future generations; and to see humans as part of the living and physical world. All in all, the guides issued in the 21st century from now on, need to be based on a new paradigm

WHAT PARADIGMS ARE

Paradigms express ideology. They encapsulate ideas, principles, theories, and concepts that are created and shaped by beliefs, discoveries, knowledge, intentions, assumptions, objectives, and perceived priorities and needs. They define and govern fields of human activity.

Prevailing paradigms, which practitioners may take for granted or be unaware of, determine, circumscribe and control accepted thinking, standards and research, and so shape policies and actions. As ways of viewing what is seen as reality, they are like maps.[44,45]

No science of any type is absolute or final. There is no such thing as one complete, objective account of nature. Sciences are dynamic. They are not merely logical or mathematical. They begin with ideas, which are then developed and tested by observations, experiments, new discoveries and experience. No science is 'the final truth'.

Paradigms may remain intact for centuries, or be accepted as dogmas, or may be formulated relatively recently, or be fragile or contested. Like maps, paradigms need to be redrawn when they are evidently inadequate or misleading. If anomalies, confusions, paradoxes or crises emerge and persist, or circumstances and needs change, paradigm 'shifts' are liable to be implied or proposed, as here, and as now often in the literature, after which the prevailing paradigm may be adjusted, reshaped or eventually fully replaced. The proposed shifts are like redrawn maps. The actual shifts, as in what become reshaped new standard textbooks, teaching, practice, policies and actions, are like explorations that enable the creation of new societies.

Replacement of established paradigms that have governed conventional thinking and practice for a long time is likely to be a gradual process. A competing paradigm may be conceived and proposed, as here, which is then discussed, adjusted, tested and publicised, and seen by a growing number and then by a critical mass of influential organisations and scholars as more valuable, plausible, relevant or useful. Then the prevailing paradigm is indeed liable to be replaced by a whole new paradigm, complete with definition and principles, which prevails.[46,47] This all takes time. Max Planck, the originator of quantum theory, observed, perhaps pessimistically:[48]

'A great scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it'.

PROPOSED PARADIGM SHIFT 1
THE NEW NUTRITION SCIENCE

What now follows is an account of three initiatives which together propose or indicate a whole new paradigm for food and nutrition science. All three have been devised and developed as teamwork and have become used and supported by thousands of scholars, commentators and organisations and citizens in many countries. Two of them are currently widely recognised and publicised on the internet and in social, broadcast, and print media. All build on supportive or convergent work that has been done previously and recently, some listed in the acknowledgements that follow this commentary.

The biochemical paradigm governing nutrition science was challenged in 2002, at conferences in Australia and New Zealand whose presentations were organised by Mark Wahlqvist, then President of the International Union of Nutritional Sciences. The opening plenary session was developed and published as two papers in this journal.[44,45] The introduction to the first paper stated: *'A new nutrition is emerging,.. whose ideology places humans within nature, and whose theses make a wider frame, able to fit the world as we can discern it. The new nutrition gives equal value to personal, population and planetary health, with all that implies*'. The papers proposed a new map for nutrition science.

Then in April 2005 a new conceptual framework for nutrition, amounting to a proposed paradigm shift, was formulated, agreed and published as the New Nutrition Science project. This built on and synthesised previous work.[49,51]

A total of 25 scholars and authors, including Mark Wahlqvist, Ricardo Uauy and Ibrahim Elmadfa, the three successive presidents of the International Union of Nutritional Sciences (IUNS) between 2001 and 2012, formed a panel for a three-day workshop at the University of Giessen, Germany, under the aegis of IUNS. As well as food and nutrition scientists its membership included people qualified or practicing in epidemiology,

population health, natural history, agriculture, economics, philosophy and medicine. Several members were advisors to national governments or United Nations agencies. The workshop was chaired by Christopher Beauman of the European Bank for Reconstruction and Development. As explained by Mark Wahlqvist:[52]

'*The task has been to … formulate a new definition, new goals and a new conceptual framework for a science fully equipped to meet the challenges and the opportunities of the world in which we now live, in this new century. This I believe to be the most urgent and exciting task now facing our profession'.*

The proceedings of the workshop were published in September 2005 in a whole special issue of the journal *Public Health Nutrition.*[53-55] The key product of the workshop is *The Giessen Declaration,*[56] agreed and signed by all workshop members. This defines nutrition suitable for the 21st century as a social and environmental as well as a biological and behavioural science. A passage in the Declaration summarises the 21st century context and needs:

'The human species has now moved from a time in history when the science of nutrition, and food and nutrition policy, has 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'.

Another passage specifies principles:

'The overall principles that should guide nutrition science are ethical in nature. Its 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'.

The *Declaration* and accompanying papers on the New Nutrition Science amount to the expansion of nutrition to a central part of public health on a grand scale, making it perennially positive, flexible and valuable. The New Nutrition is co-equally committed to the human, living and physical worlds, to present and future generations, and to good health and well-being as well as to prevention of disorders, disabilities and diseases. Its scope is global. It is holistic, discerning the big picture, of food systems and supplies and how these shape dietary patterns – what societies, families and people habitually eat and drink. Ricardo Uauy stated in the special issue of *Public Health Nutrition*:[57]

'The most important and urgent issues that confront nutrition scientists in the twenty-first century are beyond the scope of conventionally defined human biology. We must be willing to encompass the social, economic, political and human rights dimensions of nutrition'.

In September 2005, The New Nutrition was launched in a plenary presentation at the 18th IUNS International Conference on Nutrition held in Durban, South Africa. Between 2006 and 2007 it was discussed and endorsed at workshops, meetings or conferences held in Spain (Barcelona), Australia (Hobart), China (Hangzhou), Canada (Montreal), Sweden (Stockholm), Chile (Santiago), and Brazil (Rio de Janeiro). An additional economic dimension was proposed at the Australian meeting, which was discussed and approved by the New Nutrition council.

Figure 1. The New Nutrition dimensions agreed in 2006.[58] *Reproduced with permission.*

Public Health Nutrition, a textbook published in 2007, stated:[59]

The New Nutrition Science is… a holistic paradigm because it is informed by analysis… based on integrating social (including cultural, economic and political) dimensions, with the 'classical' biological (biochemical, physiological, medical) dimension'.

New Nutrition concepts were incorporated in declarations prepared and agreed at two further conferences. In 2008 *The Hyderabad Declaration. Public Health in the 21st Century*, which also included the concept of fundamental and elemental public health needed for impoverished populations and communities, was presented at the opening conference of the Public Health Foundation of India and published in its proceedings.[60] In 2009 the *Istanbul Declaration, Health The First Human Right*, was agreed at the annual conference of the World Federation of Public Health Associations.[61] The language of relevant United Nations agencies is now usually consistent with *The Giessen Declaration.*

Table 2 indicates the qualities of the New Nutrition Science. It fosters the meaning of health as stated by the World Health Organization: 'Complete physical, mental and social well-being and not merely the absence of disease or infirmity'.[62] It also implies a systems multi-disciplinary approach taking social, economic and environmental impacts and benefits fully into account, of which impressive examples have now been prepared and published.[43,63-65]

PROPOSED PARADIGM SHIFT 2
THE NOVA FOOD CLASSIFICATION

The New Nutrition amounts to a map that includes much new identified territory. What it does not do, is show what has gone wrong with food systems and supplies and dietary patterns and specify how to put them right. This

Table 2. Proposed paradigm shift 1.[53-56]
The New Nutrition is convincing

Key reasons why, are that it:
-Establishes nutrition as central in public health
-Makes nutrition clear, integrated, effective
-Uses evolutionary, ecological, ethical principles
-Embraces the living, natural and physical worlds
-Includes personal, population, planetary health
-Integrates biological, social, environmental science
-Addresses well-being, not only disorders, diseases
-Involves anthropocentric impacts on life on earth
-Examines the past and is for generations to come
-Respects established food systems, dietary patterns
-Recognises dietetics as the good life well led
-Fits the facts and faces the future of the 21st century

was done soon afterwards by the NOVA food classification system. NOVA was originated in the global South, in Brazil, first published internationally in 2009,[66,67] and adopted in the current second Brazilian official national food guide issued in 2014, discussed below.[68]

Boyd Swinburn, lead author of the 2019 *Lancet* report on obesity, under-nutrition and climate change,[64] states: *'One major paradigm shift in the last decade has been the NOVA classification of foods based on the level of processing rather than nutrient composition'*.[65] The key perception of NOVA is that the nature, purpose and extent of food processing has become the main dietary determinant of states of health and well-being, and of obesity and diabetes and various disagreeable, dangerous or deadly disorders, disabilities and diseases of most if not all human vital organs and systems.[67,69,70]

Since the 1980s, food systems and supplies and dietary patterns all over the world have been or are becoming transformed. The driver is what is done to food before it is purchased and consumed, which is to say, food processing.[67,69,70]

Almost all food is processed in some way before it is consumed. NOVA classifies all foods into four groups: unprocessed and minimally processed; processed culinary ingredients; processed; and ultra-processed.[67,69,70] Most individual processes are benign or neutral. Some are malign, such as the partial hydrogenation of oils.[71] Minimal processes such as drying, peeling or chopping have various functions such as to preserve whole food or make it palatable. Processed culinary ingredients (such as refined oils, sugar and salt) are rarely if ever consumed by themselves and are prepared with unprocessed and minimally processed food to make dishes and meals. Processed foods are modified from their original whole form by processes such as canning or curing.

Ultra-processed products are not modified foods. Their ingredients are chemically altered proteins, fats and carbohydrates made into imitations of real foods by sophisticated use of chemical additives. Many are high both in sugar and fat, a combination very rare in nature. Most include little or no whole food. They are designed to be convenient (durable, ready-to-consume anytime, anywhere), delicious (often hyper-palatable, and even addictive), and highly profitable while relatively affordable (low-cost ingredients), and liable to displace all other foods. Most are branded and made by transnational corporations that market them aggressively, often with colossal budgets.[67,69,70]

The matrix or structure of whole and minimally processed foods contain very many constituents, in proportions that have evolved to ensure the function and health of living organisms. When foods are ultra-processed their structure is destroyed. The chemical constituents including additives they contain are artificially formulated and have no natural balance. Many of these have no equivalents in nature, so humans are not evolved and are unlikely to be adapted to metabolise them.[72,73]

Production and consumption of ultra-processed food has greatly increased especially since the 1980s. It now amounts to a half or more of the dietary energy consumed in high-income countries such as the USA, Canada and the UK. Rates are rapidly rising in many lower-income countries.[67,69,70] In the same period, rates of obesity and diabetes are and are becoming much higher.

Studies including meta-analyses carried out in Australia, Brazil, Canada, Chile, China, Colombia, France, Italy, Korea, Mexico, Portugal, Spain, Taiwan, the UK, the USA and other countries show that ultra-processed food causes diets to deteriorate and is a cause of overweight, obesity, and diabetes. Other conditions and diseases implicated include hyperuricemia, hypertension, cerebrovascular disease, coronary heart disease, breast cancer, non-alcoholic liver disease, renal function decline, Crohn's disease, and cardiovascular, cerebrovascular and all-cause mortality.

What effect ultra-processed foods have on the human microbiome, the bacterial separate while inter-related ecosystem within the gut, often now identified as a vital organ, is not yet well-known. But it is likely to be harmful. So far, epidemiologist Tim Spector of King's College, London, thinks that the harm is done by various additives. He says: '*The data are probably best for artificial sweeteners that are derived from things like paraffin and the petrol industry, so our bodies and our microbes are not used to breaking them down. But it could be other stuff, like the enzymes you don't get on the label, or emulsifiers. There are few studies on emulsifiers, and nearly all in animals, but they show that you get reduced diversity and more inflammatory microbes… I think it's safe to say that ultra-processed foods are bad for your gut microbes and we should avoid eating them regularly'*.[74]

Now there is also good evidence that some ultra-processed foods are addictive. Ashley Gearhardt of the University of Michigan, a specialist in this field, says: *'Ultra-processed foods are created in ways that parallel the development of addictive drugs, including the inclusion of an unnaturally high dose of rewarding ingredients that are rapidly absorbed into the system and enhanced through additives. As with addictive drugs, some (but not all) individuals exhibit an addictive pattern of consumption marked by diminished control over intake, intense cravings, and an inability to cut down despite negative consequences'*.[75]

'The need to reshape global food processing', a statement addressed to the September 2021 United

Nations Food Systems Summit, concludes:[38]

The totality of evidence… shows beyond reasonable doubt that increased consumption of ultra-processed foods is a major contributor to the pandemic of obesity and related diseases. There is also mounting evidence of the harmful effects of the ultra-processed food industry on the planet, through its global demand for cheap ingredients that destroy forests and savannahs, its displacement of sustainable farming, and its resource-intensive manufacturing and packaging'.

Ultra-processing has been prominently featured on the internet and on broadcast and print media in many countries. In 2021 a *Newsweek* cover feature denounced ultra-processed food. Its cover picture, headlined TOXIC FOOD, is of a cheeseburger with a label: '*WARNING. Ultra-processed Food Raises the Risk of Diabetes, Cancer, Heart Disease, Obesity, and Dying of COVID-19'*.[76] Also in 2021, physician, microbiologist and broadcaster Chris van Tulleken showed on BBC1, the main BBC television channel, the effect on him of eating for a month a diet of 80% ultra-processed food, as now eaten by one in five people in the UK.[77] After the month was over, he reported poor sleep, heartburn, unhappy feelings, anxiety, sluggishness, and a low libido. He also had piles from constipation. He gained 6.5 kilograms. He said: 'I felt ten years older'.

Attention to ultra-processed food has tended to obscure the main message of NOVA. This is positive. Dietary patterns based on diverse and varied unprocessed and minimally processed food and processed culinary ingredients with some processed foods, made into freshly prepared meals, maintain good health and well-being and protect against disease. Long-established dietary patterns such as the northern Mediterranean diet, those of various Asian countries such as within China, Korea, India and Japan, and countries and regions within Latin America and Europe, are examples.

Table 3 indicates the qualities of the NOVA food classification system. Some are as follows. It transcends the chemical classification of foods. It explains the explosive world-wide rise of obesity and diabetes that has taken place especially since the 1980s. It is easy to understand. It enables comparable studies examining the effects of ultra-processed food on health and disease to be carried out all over the world. It proves beyond reasonable doubt that ultra-processed foods are pathogenic. It shifts responsibility for obesity, diabetes and other conditions from consumers to producers. It applies world-wide and to people of all ages and classes. It identifies healthy food patterns, based on whole and minimally processed foods made into freshly prepared meals together with processed culinary ingredients and some processed foods.

Table 3. Proposed paradigm shift 2.[67,69,70]
The NOVA food classification is comprehensive

Key reasons why, are that it:
-Transcends identification of food with chemicals
-Changes the focus of nutrition to production
-Accounts for pandemic obesity and diabetes
-Endorses essential and benign food processing
-Validates whole and minimally processed food
-Is supported worldwide by scientific investigation
-Shows that ultra-processed food is pathogenic
-Applies to all countries and societies
-Recommends foods to which humans are adapted
-Identifies fresh dishes and meals as healthy
-Includes complete human body systems
-Works throughout life from infancy to old age

PROPOSED PARADIGM SHIFT 3
THE BRAZILIAN FOOD GUIDE

The outstanding exception to the food guides based on 'classic' nutrition science is the 152-page *Dietary Guidelines for the Brazilian Population*, issued in November 2014, and available in Portuguese, Spanish, and English.[68] As stated by the Food and Agriculture Organization of the United Nations, it contains 'a full set of information and recommendations for all Brazilians… to promote the health and well-being of people, families, communities, and the whole Brazilian population, now and in future'.[78]

This *Guide* was commissioned, overseen, approved, and published by the federal Ministry of Health, after a three-year process in partnership with the Pan American Health Organization. Successive drafts were evaluated in many workshops with public health professionals and civil society organizations from all 26 Brazilian States. Drafts were circulated on-line for comments; 3,125 were received, compiled and considered, and then the final draft was completed. Over 60,000 copies of the printed versions have been distributed to health professionals, health centres, schools, hospitals and other places throughout the country.[68,79,80]

The *Guide* begins by stating the principles on which it is based. The first is: 'Diet is more than intake of nutrients', which is to say: *'Diet…refers to how foods are combined and prepared in the form of meals, how these meals are eaten, and also to cultural and social dimensions of food choices, food preparation and modes of eating'*. The second is: 'Dietary recommendations need to be tuned to their times'. An example is: *'Rates of obesity and diabetes have been rapidly increasing'* in Brazil and many other middle-income countries. The third is: '*Healthy diets derive from socially and environmentally sustainable food systems'*. This points out that: *'In most parts of the world, the means of production and distribution of food has been changing, in ways that jeopardise the equitable distribution of wealth, the autonomy of farmers, the generation of employment… and the protection of natural resources and biodiversity, as well as production of safe and healthy food'*. The fourth is: 'Different sources of knowledge inform sound dietary advice'. As well as experimental and clinical studies: *'Traditional dietary patterns, evolved and adapted often for very many generations… are… an essential natural experiment that needs to inform guidance on nutrition and on health in all senses'*. Fifth is: 'Dietary guidelines broaden autonomy in food choices'. This is developed by knowledge that: *'Many factors – whether of a physical, economic, political, cultural or social nature – can positively or negatively influence eating patterns'*.[68]

The focus of the *Guide* is not on chemical constituents of foods, but on foods, meals and dietary patterns. Its recommendations are not in effect for artificial diets never normally consumed, made up from foods whose constituents have been variously calculated to be adequate or optimal, but from actual diets habitually consumed by around one-fifth of the Brazilian population. These were analysed from the official national Household Budget Survey of the diets consumed in all Brazilian regions, urban and rural areas, and all social classes. They typically are based on the long-established Brazilian staples of rice, beans and greens, with some meat, together with salads and fruits. Eight various breakfasts and lunches and dinners are shown in photographs, together with examples of beans, cereals, roots and tubers, vegetables, fruits, nuts, milk and cheese, meat, and water.[68]

The four recommendations of the *Guide* for citizens and family members are as follows. First: *'Make natural or minimally processed foods the basis of your diet'*. Second: '*Use oils, salt and sugar in small amounts for seasoning and cooking foods'*. Third: *'Limit the use of processed foods, consuming them in small quantities… as part of meals based on natural or minimally processed foods'*. Fourth: *'Avoid ultra-processed foods'*. The *Guide* also has an overall 'golden rule': *'Always prefer natural or minimally processed foods and freshly made dishes and meals to ultra-processed foods'*.[68]

The *Guide* has been widely celebrated. In the USA, the headline in *The Nation* was 'Welcome to Brazil, where a food revolution is changing the way people eat'.[81] *The Atlantic* summarised: *'A revolutionary nutrition strategy based around a few simple rules: Eat food. Mostly plants that are native to your country. And absolutely nothing "ultra-processed" '*.[82] The news website *Vox* headlined: 'Brazil has the best nutritional guidelines in the world', and gave its context: *'The way we talk about nutrition in this country is absurd. And you only need to look as far as Brazil to understand why. Yesterday, a US-government appointed scientific panel released a 600-page report that will inform America's new dietary guidelines…They take a rather punitive approach to food, reducing it to its nutrient parts and emphasising its relationship to obesity. Food is removed from the context of family and society and taken into the lab or clinic. Brazil… does exactly the opposite. Their national guidelines don't dwell on nutrients, calories, or weight loss... Instead, they focus on meals, and encourage citizens to simply cook whole foods at home, and to be critical of the seductive marketing practices of Big Food'*.[83]

Recommendations on ultra-processed food products are included in guides issued by the Pan American Health Organization of the World Health Organization. They are also featured in the national guides of some other Latin American countries, and Malaysia, Israel and France. 'Choose minimally processed foods instead of ultra-processed foods' is one of the ten dietary pattern recommendations of the 2021 American Heart Association *Scientific Statement on Dietary Guidance to Improve Cardiovascular Health.* In 2021, the EASL-Lancet Liver Commission made similar recommendations for preventing liver diseases.[38,84-86]

The transnational corporations that make and sell most ultra-processed food dislike the *Guide*. It was flat-out attacked in September 2020. A 'technical note' from officials at the Brazilian Ministry of Agriculture, Livestock and Supply, supported by the Brazilian Food Industry Association, leaked to the media. The note claimed that the *Guide* was 'one of the worst on the planet' and called on the Ministry of Health urgently to review it, and to cut out its recommendation to avoid consumption of ultra-processed food products. In response, 33 scholars from the USA, Canada, the UK, Australia, New Zealand, South Africa, Mexico, and Chile, many of whom advise their governments, wrote to the Minister of Agriculture confirming that the 'technical note' had no valid foundation.[87]

Most impressive was the response from The Alliance for Adequate and Healthy Food and Eating, a coalition of over 30 civil society organizations. The Alliance mobilised 349 organizations and 45,983 citizens from all over Brazil. These were concerned for or engaged in human rights, food security and autonomy, child, family and public health, society, culture, employment, retailing, catering, cooking, farming, ecology, and other interests, occupations and professions. In support of the *Guide*, the Alliance stated: '*The increasing number of people affected by chronic non-communicable diseases associated with the consumption of ultra-processed foods… is not only Brazilian but is global… Chronic diseases are associated with the severity and lethality of Covid-19. This further reinforces… the need for equitable, resilient and sustainable food systems [which] … should aim first and only at the health of people and the planet'*. Faced with this demonstration of nationwide solidarity, the Minister of Agriculture repudiated the 'technical note' and confirmed that nutritional issues are the responsibility of the Ministry of Health.[87]

In 2021 the Ministry of Health published a further food guide, the 262-page *Dietary Guidelines for Brazilian Children Under 2 Years of Age*, in Portuguese and English. This emphasises the vital importance of extended exclusive breastfeeding. It incorporates the philosophy, findings and recommendations of the 2014 *Guide.*[88]

Table 4 indicates the qualities of the 2014 Brazilian food guide. Some are as follows. It states its principles. The dietary pattern it recommends corresponds to that of a proportion of the Brazilian population. It is based on freshly prepared meals. It is for everybody, designed to be read and used by professionals and by people as citizens and family members. It is universal and can be readily adjusted for all other countries and regions. It promotes positive good health and well-being, not just avoidance of disorders, disabilities and diseases. It involves society, economics, and politics, and the living and physical worlds. It is in the great tradition of public health.

THE NEW PARADIGM

In order to shift a paradigm that is no longer useful, and to establish a new paradigm that addresses evident crises, meets current needs, and accommodates known facts, its name, definition, purpose and principles need to be agreed. Those offered below are developed from those

Table 4. Proposed paradigm shift 3.[68,79,80]
The Brazilian food guide is compelling

Key reasons why, are that it:
-Stands on explicit, timely, rational, ethical principles
-Recommends diets actually eaten within populations
-Uses concepts and language accessible to everybody
-Addresses people as citizens and family members
-Separates whole, processed, ultra-processed foods
-Embraces good health, well-being, not only ill-health
-Celebrates freshly prepared meals and social eating
-Proposes action on existing knowledge and wisdom
-Considers society, economics, politics, environment
-Integrates human, living, natural, physical worlds
-Mobilises professional, civil society organisations
-Applies everywhere to everybody, now and in future

specified for the New Nutrition Science as a result of the series of workshops, conferences and other meetings after the conference in South Africa (Durban), held in Germany (Giessen), Spain (Barcelona), Australia (Hobart), China (Hangzhou), Canada (Montreal). Sweden (Stockholm), Chile (Santiago), Brazil (Rio de Janeiro), India (Hyderabad) and Turkey (Istanbul), and subsequent work. They also incorporate the philosophy of the NOVA food classification and the 2014 Brazilian food guide. They are open for debate and discussion at conferences and meetings and in the literature.

Once reviewed and finally agreed, they should be declared and published in all contexts as the governing statements of the theory and practice of the science. These include the constitutions and preambles of all relevant professional societies, research centres, textbooks and journals; policy statements including all types of food guide developed and published by United Nations agencies, other relevant international and national organisations, and governments at all levels from national to municipal.

The proposed name for the science is new. It recognises that nutrition is about food and not only nutrients. It restores the concept of alimentation – food as consumed – which remains part of the name of the discipline in romance languages, as for example *alimentação e nutrição* in Portuguese, and *Lebensmittel und Ernährung* in German. The science has various components. For example, much of what is now termed 'nutrition' is actually clinical nutrition, one of whose concerns is the alleviation and treatment of nutritional deficiencies.

Like all organised rational human activity, food and nutrition science needs to be based on explicit principles. These give context, structure and meaning, govern and guide thought and action, and create purpose, force and focus to research and practice. They evolve. They can be explored and challenged at any time. They are not forever true or false; they are more or less relevant and valuable, depending on circumstances and needs. They answer 'why?' and 'what for?' questions. Below are 21 that have been discussed and agreed at the meetings mentioned above, developed since then and for this commentary. More can be added. They can be adapted for different regions, countries, times and situations.[53-56,89]

Name
Food and nutrition science.

Definition
Food and nutrition science is concerned with the physical, mental, emotional, moral and spiritual health and well-being of humans, within the living and physical worlds and the biosphere. It is a central part of personal, public and planetary health. It is a biological, behavioural, cultural, economic, political and environmental discipline.

Purpose
Food and nutrition science studies and guides the nature and interactions of food systems and supplies, dietary patterns, meals, foods and drinks, and nutrients. It protects and promotes good health and well-being, and thus contributes to a world in which present and future generations fulfil their human potential, are protected from disorders and diseases, live wisely and well, and develop, sustain and enjoy an increasingly rich and diverse environment. It is the basis for policies and actions that identify, create, conserve, protect and develop rational, sustainable and equitable local, national and global food systems, so as to sustain the health, well-being and integrity of humanity, and that of the living and physical worlds and the biosphere.

Principles
General
Humanity is moving out of the era of reckless exploitation, production, and consumption. Now, human responsibilities include preservation, protection, conservation and sustenance.

Food and nutrition science follows evolutionary, ethical, and ecological principles, respects history, culture and tradition, affirms human rights, and helps to preserve and protect the human, living and physical worlds.

Food and nutrition science supports everybody to fulfil their human potential, to live in the best of health, and to develop, sustain and enjoy increasingly diverse human, living and physical environments.

Evolutionary
Food and nutrition theory, policy and practice, respects the evolutionary processes that over millions of years have shaped the evolution of hominid species and eventually *Homo sapiens*.

Ethical
A special responsibility of food and nutrition science is to hand on to future generations an improved human, living and physical environment: healthy people, healthy populations, and a healthy planet.

Ecological
All relevant sciences, including that of food and nutrition, are concerned with the cultivation, conservation and sustenance of human, living and physical resources and the biosphere.

Historical
Food and nutrition practices consistently followed in different cultures and times in history are probably valid. They do not need proof to be accepted, adopted or adapted, but disproof to be rejected.

Biological
Nutrition defined as a biological science cannot slow or stop disease epidemics. The social, cultural, economic, political and environmental determinants of epidemics are outside its scope.

Nourishment
The single nutritional factor that most protects human health lifelong is extended exclusive breastfeeding. Breastfeeding is also emotionally vital, socially valuable, and environmentally sound.

The main dietary determinant of health is the extent to which foods are processed. Meals mainly made with unprocessed and minimally processed foods are healthy. Ultra-processed products are harmful.

As a rule, natural foods that are whole or modified by simple processes are healthy. Artificial food products formulated by sophisticated techniques are unhealthy and should be avoided.

The best nourishment is from commensal freshly prepared meals. Good company and pleasant surroundings increase enjoyment and well-being and enhance all aspects of human health.

Social
It is essential to acknowledge the vast rapid recent global, national and local social developments, and their basic and underlying driving forces, to prevent disease and sustain human well-being and health.

Cultural
Good husbandry, sound nutrition, and great gastronomy are inextricably linked. Home cooking supplies nourishment, family and social well-being and cohesion, good local relationships, and autonomy.

Economic
Food subsidies in rich countries, and tariffs imposed on food from poor countries, damage human health, social fabric, and the environment, and are a cause of intractable epidemic diseases.

Political
Basic causes of epidemics include decisions increasingly taken beyond democratic process. Effective action to control and prevent disease requires revised and renewed structures of governance at all levels.

Environmental
Rational food and nutrition policies and actions protect global renewable and non-renewable resources and sustain renewable resources. They do not depend on non-renewable resources.

Traditional
Indigenous and traditional food systems known or reliably considered to be beneficial to human health, with light environmental impact, should be preserved, protected, reinstated and developed.

Agricultural
Mixed farming systems that support the natural fertility of the soil by sustainable methods, with minimal chemical inputs, are ecologically and environmentally sound and produce healthy food.

Food systems
Healthy dietary patterns derive from socially, economically and environmentally sustainable food systems, that are based on established cultures, prevailing climate, and existing terrain.

Public health
Food and nutrition science is a central part of public health. As such it addresses the fundamental and elemental health conditions of impoverished populations and communities.

CONCLUSION
What still remains conventional or 'classic' nutrition, with its biochemical paradigm, has governed the science for close to two centuries. It is a remnant of an ideology invented in Europe in which humans were seen as superior to and separate from the living world and physical environment, free recklessly to ravage resources many of which are irreplaceable. All this must now end. In any case, initiatives designed to improve food and health are now evidently beyond its scope. It has minimal value, is no longer fit for purpose, and should be set aside as obsolete and replaced.

Proposals have recently or currently been made, as here, that imply or propose shifts of the paradigm. The still-prevailing paradigm is beginning to shift among a gradually increasing number of national governments, professional leaders, and in the United Nations. Here is the introduction to the 2021 UN Food Systems Summit:[90]

'Food is more than just what we eat. The ways in which we produce, process and consume food touch every aspect of life on this planet. Food is the foundation of our cultures, our economies, and our relationship with the natural world, and has the power to bring us together as families, communities and nations'.

What so far has been missing, is a name, definition, purposes and principles for food and nutrition science. These are offered here. The future was envisioned by the Spanish/Venezuelan José María Bengoa, a founder of public health nutrition, at the First World Congress on Public Health Nutrition in Barcelona, in September 2006. Then in his 94th year, he said:[91]

'One can glimpse a great expansion in the horizons of the science of nutrition… We are getting closer and closer, like a great magic wheel, to the ideas that the Greeks held about dietetics – as the dominion of life itself, both in the biological and social sense. It seems as if we are redefining nutrition as the beginning and end of life itself'.

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