1
Introduction to Human Nutrition: A Global Perspective on Food and Nutrition

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Key messages

- Human nutrition is a complex, multifaceted scientific domain indicating how substances in foods provide essential nourishment for the maintenance of life.
- To understand, study, research, and practice nutrition, a holistic integrated approach from molecular to societal level is needed.
- Optimal, balanced nutrition is a major determinant of health. It can be used to promote health and well-being, to prevent ill-health and to treat disease.
- The study of the structure, chemical and physical characteristics, and physiological and biochemical effects of the more than 50 nutrients found in foods underpins the understanding of nutrition.
- The hundreds of millions of food- and nutrition-insecure people globally, the coexistence of undernutrition and overnutrition, and inappropriate nutritional behaviors are challenges that face the nutritionist of today.
- Nutrition practice has a firm and well-developed research and knowledge base. There are, however, many areas where more information is needed to solve global, regional, communal and individual nutrition problems.
- The development of ethical norms, standards, and values in nutrition research and practice is needed.

1.1 Orientation to human nutrition

The major purpose of this series of four textbooks on nutrition is to guide the nutrition student through the exciting journey of discovery of nutrition as a science. As apprentices in nutrition science and practice students will learn how to collect, systemize, and classify knowledge by reading, experimentation, observation, and reasoning. The road for this journey was mapped out millennia ago. The knowledge that nutrition – what we choose to eat and drink – influences our health, well-being, and quality of life is as old as human history. For millions of years the quest for food has helped to shape human development, the organization of society and history itself. It has influenced wars, population growth, urban expansion, economic and political theory, religion, science, medicine, and technological development.

It was only in the second half of the eighteenth century that nutrition started to experience its first renaissance with the observation by scientists that intakes of certain foods, later called nutrients, and eventually other substances not yet classified as nutrients, influence the function of the body, protect against disease, restore health, and determine people's response to changes in the environment. During this period, nutrition was studied from a medical model or paradigm by defining the chemical structures and characteristics of nutrients found in foods, their physiological functions, biochemical reactions and human requirements to prevent, first, deficiency diseases and, later, also chronic noncommunicable diseases.

Since the late 1980s nutrition has experienced a second renaissance with the growing perception that the knowledge gained did not equip mankind to solve the global problems of food insecurity and malnutrition. The emphasis shifted from the medical or pathological paradigm to a more psychosocial, behavioral one in which nutrition is defined as a basic human

right, not only essential for human development but also as an outcome of development.

In this first, introductory text, the focus is on principles and essentials of human nutrition, with the main purpose of helping the nutrition student to develop a holistic and integrated understanding of this complex, multifaceted scientific domain.

1.2 An integrated approach

Human nutrition describes the processes whereby cellular organelles, cells, tissues, organs, systems, and the body as a whole obtain and use necessary substances obtained from foods (nutrients) to maintain structural and functional integrity. For an understanding of how humans obtain and utilize foods and nutrients from a molecular to a societal level, and of the factors determining and influencing these processes, the study and practice of human nutrition involve a spectrum of other basic and applied scientific disciplines. These include molecular biology, genetics, biochemistry, chemistry, physics, food science, microbiology, physiology, pathology, immunology, psychology, sociology, political science, anthropology, agriculture, pharmacology, communications, and economics. Nutrition departments are, therefore, often found in Medical (Health) or Social Science, or Pharmacy, or Agriculture Faculties at tertiary training institutions. The multidisciplinary nature of the science of nutrition, lying in both the natural (biological) and social scientific fields, demands that students of nutrition should have a basic understanding of many branches of science and that they should be able to integrate different concepts from these different disciplines. It implies that students should choose their accompanying subjects (electives) carefully and that they should read widely in these different areas.

1.3 A conceptional framework for the study of nutrition

In the journey of discovery into nutrition science it will often be necessary to put new knowledge, or new applications of old knowledge, into the perspective of the holistic picture. For this, a conceptual framework of the multidisciplinary nature of nutrition science and practice may be of value. Such a conceptual framework, illustrating the complex interactions between internal or constitutional factors and external environmental factors which determine nutritional status and health, is given in Figure 1.1.

On a genetic level it is now accepted that nutrients dictate phenotypic expression of an individual's genotype by influencing the processes of transcription, translation, or post-translational reactions. In other words, nutrients can directly influence genetic (DNA) expression, determining the type of RNA formed (transcription) and also the proteins synthesized (translation). For example, glucose, a carbohydrate macronutrient, increases transcription for the synthesis of glucokinase, the micronutrient iron increases translation for the synthesis of ferritin, while vitamin K increases post-translational carboxylation of glutamic acid residues for the synthesis of prothrombin. Nutrients, therefore, influence the synthesis of structural and functional proteins, by influencing gene expression within cells.

Nutrients also act as substrates and cofactors in all of the metabolic reactions in cells necessary for the growth and maintenance of structure and function. Cells take up nutrients (through complex mechanisms across cell membranes) from their immediate environment, also known as the body's internal environment. The composition of this environment is carefully regulated to ensure optimal function and survival of cells, a process known as homeostasis, which gave birth to a systems approach in the study of nutrition.

Nutrients and oxygen are provided to the internal environment by the circulating blood, which also removes metabolic end-products and harmful substances from this environment for excretion through the skin, the kidneys, and the large bowel.

The concerted function of different organs and systems of the body ensures that nutrients and oxygen are extracted or taken up from the external environment and transferred to the blood for transport and delivery to the internal environment and cells. The digestive system, for example, is responsible for the ingestion of food and beverages, the breakdown (digestion and fermentation) of these for extraction of nutrients, and the absorption of the nutrients into the circulation, while the respiratory system extracts oxygen from the air. These functions are coordinated and regulated by the endocrine and central nervous

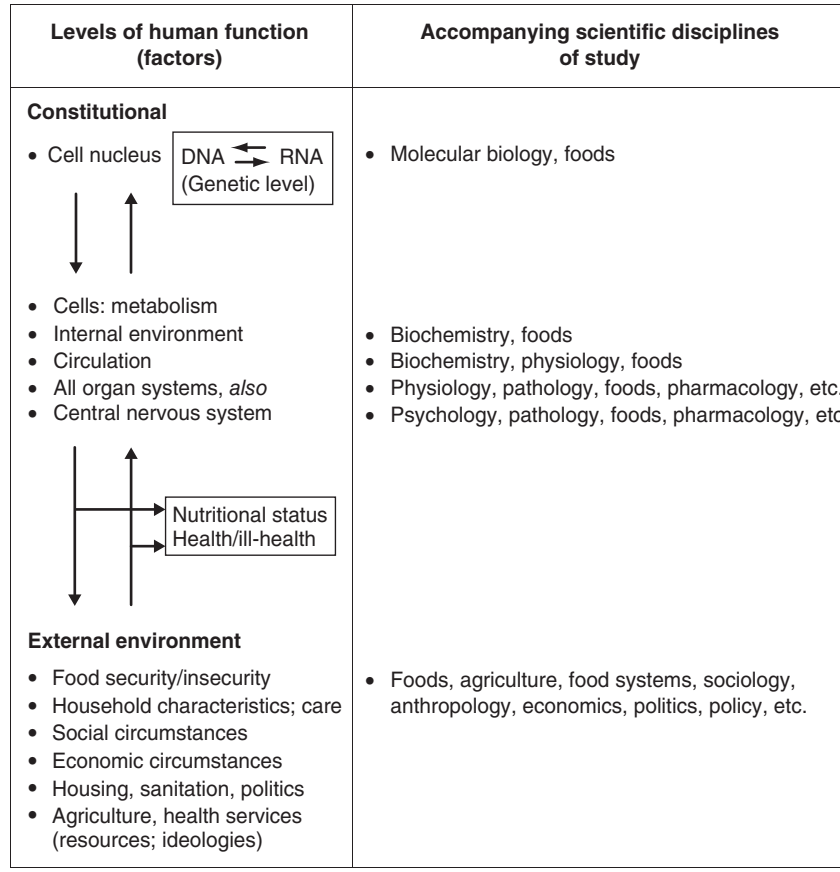

Figure 1.1 Conceptual framework for a holistic, integrated understanding of human nutrition.

systems in response to the chemical and physical composition of the blood and internal environment, and to cellular needs.

The health or disease state of the different organs and systems will determine the nutrient requirements of the body as a whole.

The central nervous system is also the site or "headquarters" of the higher, mental functions related to conscious or cognitive, spiritual, religious, and cultural behaviors, which will determine, in response to the internal and external environments, what and how much will be eaten. What and how much is eaten will further depend on what is available, influenced by a host of factors determining food security. All of these factors, on an individual, household, community, national, or international level, shape the external environment.

During the first renaissance of nutrition, emphasis was placed on the study of nutrients and their functions. A medical, natural science or biological model underpinned the study of the relationships between nutrition and health or ill-health. During the second renaissance, these aspects are not neglected, but expanded to include the study of all other external environmental factors that determine what and how much food and nutrients are available on a global level. These studies are underpinned by social, behavioral, economic, agricultural, and political sciences. The study of human nutrition therefore seeks to understand the complexities of both social and biological factors on how individuals and populations maintain optimal function and health, how the quality, quantity and balance of the food supply are influenced, what happens to food after it is eaten, and the way that diet affects health and well-being. This integrated approach has led to a better understanding of the causes and consequences of malnutrition, and of the relationship between nutrition and health.

1.4 Relationship between nutrition and health

Figure 1.2 shows that individuals can be broadly categorized into having optimal nutritional status or being undernourished, overnourished, or malnourished. The major causes and consequences of these nutritional states are indicated. It is important to realize that many other lifestyle and environmental factors, in addition to nutrition, influence health and well-being, but nutrition is a major, modifiable, and powerful factor in promoting health, preventing and treating disease, and improving quality of life.

1.5 Nutrients: the basics

People eat food, not nutrients; however, it is the combination and amounts of nutrients in consumed foods that determine health. To read one must know the letters of the alphabet; to do sums one must be able to count, add, subtract, multiply, and divide. To understand nutrition, one must know about nutrients. The study of nutrients, the ABC and numeric calculations of nutrition, will form a major part of the student's nutrition journey, and should include:

- the chemical and physical structure and characteristics of the nutrient
- the food sources of the nutrient, including food composition, the way in which foods are grown, harvested, stored, processed and prepared, and the effects of these on nutrient composition and nutritional value
- the digestion, absorption, circulatory transport, and cellular uptake of the nutrient, as well as regulation of all these processes
- the metabolism of the nutrient, its functions, storage, and excretion
- physiological needs (demands or requirements) for the nutrient in health and disease, and during special circumstances (pregnancy, lactation, sport events), as well as individual variability
- interactions with other nutrients, nonnutrients (phytochemicals), antinutrients, and drugs

Nutritional situation		Health consequences, outcomes
Optimum nutrition Food-secure individuals with adequate, balanced and prudent diets	→	Health, well-being, normal development, high quality of life
Undernutrition: hunger Food-insecure individuals living in poverty, ignorance, politically unstable environments, disrupted societies, war	→	• Decreased physical and mental development • Compromised immune systems • Increased infectious diseases • Vicious circle of undernutrition, underdevelopment, poverty
Overnutrition Overconsumption of food, especially macronutrients, plus: • low physical activity • smoking, stress, alcohol abuse	→	Obesity, metabolic syndrome, cardiovascular disease, type 2 diabetes mellitus, certain cancers: chronic NCDs, often characterized by overnutrition of macronutrients and undernutrition of micronutrients
Malnutrition Nutrition transition: Individuals and communities previously food insecure → confronted with abundance of palatable foods → some undernourished, others too many macronutrients and too few micronutrients	→	Double burden of infectious diseases plus NCDs, often characterized by overnutrition of macronutrients and undernutrition of micronutrients

Figure 1.2 Relationship between nutrition and health. NCD, noncommunicable disease.

- the consequences of underconsumption and overconsumption of nutrients
- the therapeutic uses of the nutrient
- factors influencing food and nutrition security and food safety.

There are more than 50 known nutrients (including amino acids and fatty acids) and many more chemicals in food thought to influence human function and health (Box 1.1). Nutrients do not exist in isolation, except for water and others in some pharmaceutical preparations. In foods, in the gut during digestion, fermentation and absorption, in the blood during transport, and in cells during metabolism, nutrients interact with each other. Therefore, a particular nutrient should not be studied in isolation, but integrated with other nutrients and seen in the context of total body function. The study of nutrition also includes how to determine nutrient requirements to make recommendations for intakes and how nutritional status is monitored by measuring intakes, anthropometry, body composition, biochemical markers reflecting nutritional status, and the clinical signs of malnutrition.

This knowledge of nutrients and their functions will enable the nutritionist to advise individuals what and how much to eat. However, this knowledge is not sufficient to understand and address the global problem of malnutrition facing mankind today. This perception has resulted in the cultivation of social science disciplines to support knowledge from the biological sciences to address global malnutrition.

1.6 Global malnutrition

It is a major tragedy that millions of people currently live with hunger, and fear starvation. This is despite the fact that food security or "access for all at all times, to a sustainable supply of nutritionally adequate and safe food for normal physical and mental development and healthy, productive lives" is a basic human right embedded in the constitution of most developing countries. It is also despite the fact that sufficient food is produced on a global level (see Box 1.2). Food

Box 1.2

Food insecurity: when people live with hunger, and fear starvation.
Food security: access for all, at all times, to a sustainable, affordable supply of nutritionally adequate and safe food for normal physical and mental development and healthy, productive lives.

Box 1.1 Classes of nutrients for human nutrition

Class/category	Subclass/category	Nutrient examples
Carbohydrates (macronutrients)	Monosaccharides Disaccharides Polysaccharides	Glucose, fructose, galactose Sucrose, maltose, lactose Starch and dietary fiber
Proteins (macronutrients)	Plant and animal source proteins	Amino acids ($n = 20$): aliphatic, aromatic, sulfur-containing, acidic, basic
Fats and oils (lipids) (macronutrients)	Saturated fatty acids Monounsaturated fatty acids Polyunsaturated fatty acids (n-3, n-6, n-9)	Palmitic and stearic acid Oleic (*cis*) and elaidic (*trans*) fatty acids Linoleic, α-linolenic, arachidonic, eicosapentaenoic, docosahexaenoic acid
Minerals (micronutrients)	Minerals and electrolytes Trace elements	Calcium, sodium, phosphate, potassium, iron, zinc, selenium, copper, manganese, molybdenum, fluoride, chromium
Vitamins (micronutrients)	Fat soluble	Retinol (A), calciferols (D), tocopherols (E), vitamin K
	Water soluble	Ascorbic acid (C), thiamine (B_1), riboflavin (B_2), niacin (B_3), pyridoxine (B_6), folate, cobalamin (B_{12})
Water	Water	Water

insecurity is an obstacle to human rights, quality of life, and human dignity. It was estimated that, during the last decade of the twentieth century, 826 million people were undernourished: 792 million in developing countries and 34 million in developed countries. In developing countries, more than 199 million children under the age of 5 years suffer from acute or chronic protein and energy deficiencies. An estimated 3.5–5 billion people are iron deficient, 2.2 billion iodine deficient, and 140–250 million vitamin A deficient. This has led to several global initiatives and commitments, spearheaded by a number of United Nations organizations, to reduce global undernutrition, food insecurity, hunger, starvation, and micronutrient deficiencies. Some progress has been made in reducing these numbers, but the problems are far from solved. Some of the initiatives are:

- the 1990 United Nations Children's (Emergency) Fund (UNICEF)-supported World Summit for Children, with a call to reduce severe and moderate malnutrition among children under 5 years of age by half the 1990 rate by the year 2000, including goals for the elimination of micronutrient malnutrition
- the 1992 World Health Organization/Food and Agriculture Organization (WHO/FAO) International Conference on Nutrition that reinforced earlier goals and extended them to the elimination of death from famine
- the 1996 FAO-supported World Food Summit during which 186 heads of state and governments pledged their political will and commitment to a plan of action to reduce the number of undernourished people to half their 1996 number by 2015
- the establishment in 1997 of the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) and their Interagency Working Group (IAWG), which consists of 26 international organizations and agencies with a shared commitment to reduce food insecurity and vulnerability and its multidimensional causes rooted in poverty; information about these initiatives can be accessed at: http://www.fao.org/
- Millennium Development Goals: the United Nations articulated eight goals, ranging from halving extreme poverty and hunger, halting the spread of the human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) and providing universal primary education, to be reached by the target date of 2015; the blueprint of these goals was agreed to by all the world's countries and leading development institutions.

A 2001 report from the FAO indicated that in 1997–1999 there were 815 million undernourished people in the world, of whom 777 million were in developing countries, 27 million in transitional countries and 11 million in the industrialized countries. The annual decrease in undernourished people from the 1990–1992 period was 6 million. To reach the World Food Summit's goal of halving the number of undernourished in developing countries by 2015, it is estimated that the annual decrease required is 22 million.

Clearly, this is a huge challenge for food and nutrition scientists and practitioners. It would need a holistic approach and understanding of the complex, interacting factors that contribute to malnutrition on different levels. These include immediate, intermediate, underlying, and basic causes:

- individual level or immediate causes: food and nutrient intake, physical activity, health status, social structures, care, taboos, growth, personal choice
- household level or intermediate causes: family size and composition, gender equity, rules of distribution of food within the household, income, availability of food, access to food
- national level or underlying causes: health, education, sanitation, agriculture and food security, war, political instability, urbanization, population growth, distribution and conflicts, war, natural disasters, decreased resources
- international level or basic causes: social, economic and political structures, trade agreements, population size, population growth distribution, environmental degradation.

To address these causes of undernutrition food-insecure and hungry communities and individuals must be empowered to be their own agents of food security and livelihood development. Complicating the task of fighting food insecurity and hunger are natural disasters such as droughts, floods, cyclones and extreme temperatures, ongoing wars and regional conflicts, as well as the devastating impact of HIV and AIDS, especially in sub-Saharan Africa.

In many developing countries, indigenous people have changed their diets and physical activity patterns

to those followed in industrialized countries. Supplementary feeding programs in these countries have often been associated with increasing trends towards obesity, insulin resistance, and the emergence of chronic diseases of lifestyle in some segments of these populations, while other segments are still undernourished.

The coexistence of undernutrition and overnutrition, leading to a double burden of infectious and chronic, noncommunicable diseases, and the multifactorial causes of malnutrition, call for innovative approaches to tackle both undernutrition and overnutrition in integrated nutrition and health-promoting programs, focusing on optimal nutrition for all.

1.7 Relationship between nutrition science and practice

The journey through the scientific domain of nutrition will, at a specialized stage, fork into different roads. These roads will lead to the different scopes or branches of nutrition science that are covered in the second, third, and fourth texts of this series. These different branches of nutrition science could lead to the training of nutrition specialists for specific practice areas.

The main aim of nutrition professionals is to apply nutrition principles to promote health and well-being, to prevent disease, and/or to restore health (treat disease) in individuals, families, communities and the population. To help individuals or groups of people to eat a balanced diet, in which food supply meets nutrient needs, involves application of nutrition principles from a very broad field to almost every facet of human life. It is therefore not surprising that these different branches or specialties of nutrition have evolved and are developing. They include clinical nutrition, community nutrition, public health, and public nutrition. It can be expected that there will be overlap in the practice areas of these specialties.

- The clinical nutritionist will counsel individuals from a biomedical–disease–behavioral paradigm to promote health, prevent disease, or treat disease. The clinical nutritionist will mostly work within the health service (facility-based settings such as hospitals, clinics, private practice).
- The community nutritionist, with additional skills from the psychosocial behavioral sciences, should be aware of the dynamics within particular communities responsible for nutritional problems. These would include household food security, socioeconomic background, education levels, childcare practices, sanitation, water, energy sources, healthcare services, and other quality-of-life indicators. The community nutritionist will design, implement, and monitor appropriate, community-participatory programs to address these problems.
- The public health or public nutritionist covers the health and care practice areas but will also be concerned with food security (agricultural) and environmental issues on a public level. The public health or public nutritionist will, for example, be responsible for nutrition surveillance, and the design, implementation, and monitoring of dietary guidelines that address relevant public health problems. A background knowledge in economics, agriculture, political science, and policy design is essential for the formulation and application of nutrition policy in a country.

Many developing countries will not have the capacity or the financial resources to train and employ professionals for different specialties. However, future specialized training and employment of different professionals could result in a capacity to address nutritional problems more effectively.

1.8 Nutrition milestones: the development of nutrition as a science

Ancient beliefs

Throughout human existence people have attributed special powers to certain foods and developed beliefs and taboos regarding foods. These were often based on climatic, economic, political, or religious circumstances and principles, but also on observations regarding the relationship between the consumption of certain foods and health.

Recorded examples are ancient Chinese and Indian philosophers who advised on the use of warming and cooling foods and spices for certain conditions and for "uplifting the soul," the Mosaic laws documented in the Old Testament which distinguished between clean and unclean foods, the fasting and halal practices of Islam, and the Benedictine monks from Salerno who preached the use of hot and moist versus

cold and dry foods for various purposes. Hippocrates, the father of modern medicine, who lived from 460 to about 377 BC, and later Moses Maimonides, who lived in the twelfth century, urged people to practice abstemiousness and a prudent lifestyle. They, and others, advised that, for a long and healthy life, one should avoid too much fat in the diet, eat more fruit, get ample sleep, and be physically active – advice that is still incorporated in the modern, science-based dietary guidelines of the twenty-first century!

Cultural beliefs

The perception that food represents more than its constituent parts is still true. Eating together is an accepted form of social interaction. It is a way in which cultural habits and customs, social status, kinship, love, respect, sharing, and hospitality are expressed. Scientists and nutrition professionals realize that, when formulating dietary guidelines for traditional living people, cultural beliefs and taboos should be taken into account and incorporated. There are numerous examples of traditional food habits and diets, often based on what was available. Today, with the world becoming a global village, cultures have learned from each other, and dietary patterns associated with good health, such as the Mediterranean diet, are becoming popular among many cultures.

The first renaissance: development of an evidence base

The knowledge of the specific health effects of particular diets, foods, and nutrients is now firmly based on the results of rigid scientific experimentation. Nutrition developed gradually as a science, but advanced with rapid strides during the twentieth century. There are numerous meticulously recorded examples of how initial (often ancient and primitive) observations about diet and health relationships led to the discovery, elucidation of function, isolation, and synthesis of the different nutrients. Perhaps the most often quoted example is James Lind's description in 1772 of how citrus fruit could cure and prevent scurvy in seamen on long voyages. The anti-scurvy factor (ascorbic acid or vitamin C) was only isolated in 1921, characterized in 1932, and chemically synthesized in 1933. Other examples of nutritional milestones are the induction of beriberi in domestic fowl by Eijkman in 1897, the observation of Takaki in 1906 that beriberi in Japanese sailors could be prevented by supplementing their polished rice diets with wheat bread, and, eventually, the isolation of the responsible factor, thiamine or vitamin B_1, by Funk in 1911. Others are the Nobel Prize-winning discovery by Minot and Murphy in 1926 that pernicious anemia is a nutritional disorder due to a lack of vitamin B_{12} in the diet, the description of kwashiorkor as a protein-deficiency state by Cecily Williams in 1935, and the discovery of resistant starch and importance of colonic fermentation for humans by nutritionists of the Dunn Clinical Nutrition Centre in the 1980s.

The history of modern nutrition as practiced today is an exciting one to read, and students are encouraged to spend some time on it. It is often characterized by heartbreaking courage and surprising insights. An example of the former is the carefully documented clinical, metabolic, and pathological consequences of hunger and starvation by a group of Jewish doctors in 1940 in the Warsaw ghetto: doctors who themselves were dying of hunger. An example of the latter is the studies by Price, an American dentist, who tried to identify the dietary factors responsible for good dental and overall health in people living traditional lifestyles. He unwittingly used a fortigenic paradigm in his research, examining the strengths and factors that keep people healthy, long before the term was defined or its value recognized.

At present, thousands of nutrition scientists examine many aspects of nutrition in laboratories and field studies all over the world and publish in more than 100 international scientific nutrition journals. This means that nutrition science generates new knowledge based on well-established research methodologies. The many types of experiments, varying from molecular experimentation in the laboratory, through placebo-controlled, double-blinded clinical interventions, to observational epidemiological surveys, and experiments based on a health (fortigenic) or a disease (pathogenic) paradigm, will be addressed in this volume (Chapter 13). The peer-review process of published results has helped in the development of guidelines to judge how possible, probable, convincing, and applicable results from these studies are. New knowledge of nutrients, foods, and diet relationships with health and disease is, therefore, generated through a process in which many scientists examine different pieces of the puzzle all

over the world in controlled scientific experiments. Therefore, nutrition practice today has a firm research base that enables nutritional professionals to practice evidence-based nutrition.

The second renaissance: solving global malnutrition

There is little doubt that improved nutrition has contributed to the improved health and survival times experienced by modern humans. However, global figures on the prevalence of both undernutrition and overnutrition show that millions of people do not have enough to eat, while the millions who eat too much suffer from the consequences of obesity. It is tempting to equate this situation to the gap between the poor and the rich or between developing and developed countries, but the situation is much more complex. Obesity, a consequence of overnutrition, is now a public health problem not only in rich, developed, food-secure countries but also in developing, food-insecure countries, especially among women. Undernutrition, the major impediment to national development, is the biggest single contributor to childhood death rates, and to impaired physical growth and mental development of children in both developing and developed countries. Moreover, a combination of undernutrition and overnutrition in the same communities, in single households, and even in the same individual is often reported. Examples are obese mothers with undernourished children and obese women with certain micronutrient deficiencies. The perception that these global problems of malnutrition will be solved only in innovative, multidisciplinary, and multisectorial ways has led to the second, very recent renaissance in nutrition research and practice.

1.9 Future challenges for nutrition research and practice

Basic, molecular nutrition

The tremendous development in recent years of molecular biology and the availability of sophisticated new techniques are opening up a field in which nutrient–gene interactions and dietary manipulation of genetic expression will receive increasing attention (see Chapter 15). The effects of more than 12 000 different substances in plant foods, not yet classified as nutrients, will also be examined. These substances are produced by plants for hormonal, attractant, and chemoprotective purposes, and there is evidence that many of them offer protection against a wide range of human conditions. It is possible that new functions of known nutrients, and even new nutrients, may be discovered, described, and applied in the future.

Clinical and community nutrition

Today, the focus has moved from simple experiments with clear-cut answers to studies in which sophisticated statistics have to be used to dissect out the role of specific nutrients, foods, and diets in multifactorial diseases. Nutrition epidemiology is now established as the discipline in which these questions can be addressed. A number of pressing problems will have to be researched and the results applied, for example:

- the biological and sociological causes of childhood obesity, which is emerging as a global public health problem
- the nutrient requirements of the elderly: in the year 2000, more than 800 million of the Earth's inhabitants were older than 60 years; to ensure a high-quality life in the growing elderly population, much more needs to be known about their nutrient requirements
- the relationships between nutrition and immune function and how improved nutrition can help to defend against invading microorganisms; in the light of the increasing HIV/AIDS pandemic, more information in this area is urgently needed
- dietary recommendations: despite sufficient, convincing evidence about the effects of nutrients and foods on health, nutritionists have generally not been very successful in motivating the public to change their diets to more healthy ones. We need to know more about why people make certain food choices in order to design culturally sensitive and practical dietary guidelines that will impact positively on dietary choices. The food-based dietary guidelines that are now being developed in many countries are a first step in this direction.

Public health nutrition

The single most important challenge facing mankind in the future is probably to provide adequate safe

food and clean water for all in an environmentally safe way that will not compromise the ability of future generations to meet their needs. In addition to the hundreds of millions not eating enough food to meet their needs for a healthy, active life, an additional 80 million people have to be fed each year. The challenge to feed mankind in the future calls for improved agriculture in drought-stricken areas such as sub-Saharan Africa, the application of biotechnology in a responsible way, interdisciplinary and intersectorial cooperation of all involved, and a better distribution of the food supply so that affordable food is accessible by all. The need for sustained economic growth in poor countries is evident.

Nutritionists have an important part to play in ensuring food security for all, a basic human right, in the future. One of their main functions would be to educate and inform populations not to rely too heavily on animal products in their diet, the production of which places a much heavier burden on the environment than plant foods. A major challenge would be to convince political leaders and governments that addressing undernutrition (the major obstacle in national development) in sustainable programs should be the top priority in developing and poor communities. Another challenge is to develop models based on the dynamics within communities and, using a human rights approach, to alleviate undernutrition without creating a problem of overnutrition. There are examples where such models, incorporated into community development programs, have been very successful (e.g., in Thailand).

Functional foods: a new development

Functional foods are new or novel foods, developed to have specific health benefits, in addition to their usual functions. Examples are spreads with added phytosterols, to lower serum low-density lipoprotein cholesterol and the risk of coronary heart disease, and the development of starchy products with resistant starch and lower glycemic indices, to help control blood glucose levels. The development and testing of functional foods is an exciting new area. These foods may help to improve or restore nutritional status in many people. However, much more should be known about suitable biomarkers to test their efficacy, variability in human response to specific food products, safety, consumer understanding, and how their health messages must be formulated, labeled, and communicated.

Food safety

The continued provision of safe food, free from microorganisms, toxins, and other hazardous substances that cause disease, remains a huge challenge. Recent experiences with animals suffering from bovine spongiform encephalopathy (BSE or mad cow disease) or from foot-and-mouth disease, or birds infected with the influenza A virus (bird flu), have shown how quickly a national problem can become an international one because of global marketing of products. The list of possible hazardous substances in foods emphasizes the need for continuous monitoring of the food supply by health officials (Figure 1.3).

<table>
<tr><td colspan="2">Microbial contamination
Bacteria and mold (fungi) producing toxins and aflatoxins
Toxins cause “food poisoning” and aflatoxins are carcinogenic</td></tr>
<tr><td>Natural toxins
Such as cyanide in cassava, solanine in potatoes; can be produced by abnormal circumstances, could be enzyme inhibitors or antivitamins</td><td>Agricultural residues
Pesticides such as DDT or hormones used to promote growth such as bovine somatotrophin</td></tr>
<tr><td>Environmental contamination
Heavy metals and minerals
Criminal adulteration, industrial pollution
Substances from packaging materials
Changes during cooking and processing of foods</td><td>Intentional additives
Artificial sweeteners
Preservatives
Phytochemicals
Modified carbohydrates (for functional foods)</td></tr>
</table>

Figure 1.3 Potential hazardous substances in food. DDT, dichloro-diphenyl-trichloroethane.

1.10 Perspectives on the future

Nutrition research and practice, although it has been around for many years, is in its infancy as a basic and applied scientific discipline. The present and future nutrition student will take part in this very exciting second renaissance of nutrition and see its maturation. However, to influence effectively the nutrition and health of individuals and populations, the nutritionist will have to forge links and partnerships with other health professionals and policy-makers, and will have to develop lateral thinking processes. The magnitude and complexity of nutritional problems facing mankind today demand concerted multidisciplinary and multisectorial efforts from all involved to solve them. Therefore, the principal message to take on a nutrition science journey is that teamwork is essential: one cannot travel this road on one's own; partners from different disciplines are needed. Another essential need is the continuous development of leadership in nutrition. Leaders on every level of research and practice are necessary to respond to the existing challenges of global malnutrition and to face future challenges.

The modern advances in molecular biology and biotechnology on the one hand, and the persistence of global malnutrition on the other, increasingly demand a re-evaluation of ethical norms, standards, and values for nutrition science and practice. Direction from responsible leaders is needed (Box 1.3). There is an urgent need for ethical guidelines and a code of conduct for partnerships between food industries, UN agencies, governments, and academics. These partnerships are necessary for addressing global malnutrition in sustainable programs.

Box 1.3 Future challenges that require exceptional leadership

- Basic molecular nutrition
  - Nutrient–gene interactions
  - Role of phytochemicals in health
  - New nutrients? New functions?
- Community and public health nutrition
  - Childhood obesity
  - Requirements of the elderly
  - Dietary recommendations
  - Nutrition of patients with human immunodeficiency virus/acquired immunodeficiency syndrome
- Public nutrition
  - To feed mankind
  - Food security
- Functional foods
  - To ensure that novel foods are effective and safe
- Food safety
  - Continuous monitoring
- Partnerships with other disciplines
- Leadership

The student in nutrition, at the beginning of this journey of discovery of nutrition as a science, must make use of the many opportunities to develop leadership qualities. May this be a happy, fruitful, and lifelong journey with many lessons that can be applied in the research and practice of nutrition to make a difference in the life of all.

Further reading

Websites

http://whq.libdoc.who.int/trs/who_trs_916
http://www.who.int/nutrition/en
http://www.ifpri.org
http://fao.org/ag/agn/nutrition/profiles_en.stm