



# TROPHOLOGICAL APPROACH IN THE DEVELOPMENT OF NUTRITION THEORIES

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## Abstract

*This article presents a trophological approach to the development of nutrition. The evolution of human views on nutrition from antiquity to the present time, including issues of perfect nutrition, is considered. The main concepts of nutrition theories are formulated. The systematized reasoning is useful for new rationale for solutions of challenges related to optimization of nutrition. Within the scope of the development of nutrition theories, the problem of perfect food plays a special role. The article presents a modern vision of perfect nutrition. The designing of trophological nutrition algorithm is based on scientific approaches that both to justify the correct consumption of food products, and also define the most reasonable way of their production, storage, distribution and disposal of food waste. The implementation of the trophological approach in theories of nutrition is also reflected in the concept of the state policy of the Russian Federation in the field of healthy nutrition among the population. This topic is also relevant in light of the sharp increase of food allergies among the various groups of population, because people who suffer from food allergies must follow a special diet to prevent the risk of allergic reactions, which can be managed using a nutritional approach.*

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## Introduction

Trophology is the science of food that studies the impact of the alimentary factor on the condition of a human body, studies the development and creation of methods for improving health through the alimentary factor. For example, the health can be improved through rational human nutrition, as well as through the improvement and management of food quality. The trophological approach has two bases: biological and evolutionary [1,2].

The founder of the concept of trophological food chains is the Russian scientist Ugolev A. M. Whole range of his works are devoted to fundamental and applied aspects of the problems of nutrition and food digestion, the theory of adequate nutrition and trophology [2–5].

The scientist Lipatov N. N. also contributed to the development of the trophological approach. Lipatov N. N. was the creator of a scientific school that considers the problems of improving the quality of food products as objects of a single exotrophic chain of their production, consumption and digestion of the food nutrients by the human body [6–9].

In scientific works [10–12], a systematic analysis was run. It resulted to defining the main links (operations) of the trophological chain of meat products from the field to the consumer. Through the ongoing collection and analysis

of data on the state of raw materials and ready-to-consume food products, their traceability shall be ensured. The traceability is possible via the introduction of a unified information and applying the analytical computer system to identify potentially dangerous or harmful conditions during production and circulation of raw materials and food products; via monitoring the composition and quality of raw materials in their resource zones, as well as monitoring of food products at all stages of its production till their sale to the consumer. The monitoring is especially important when creating functional and specialized food products, since it is necessary to trace the accumulation and preservation of both nutritional elements and xenobiotics.

For formation of this science it is necessary to develop the issue of nutrition. With the help of trophology, it's possible to overcome many difficulties that arise due to different approaches, non-congruence of estimates and experimental methods used in different sciences which study the trophological processes [4,5].

Trophology covers a range of areas: cell trophism and tissue trophism, gastroenterology, nutritional science, dietetics, food production and food turnover. Immunology, microbiology, ecology, assimilatory aspects of almost all biological and medical sciences, as well as many chemical and technological sciences, and certain scientific issues of

agriculture are also closely related to trophology. Trophology combines many links of a single assimilatory chain, artificially broken and divided between different fields of knowledge [4,5,13–17].

Trophology, to a certain extent, is already able to answer the question of what human food should be, taking into account the features of trophic processes in a body that were formed by evolution. Trophological analysis creates more reliable criteria for the formation of optimal agricultural and industrial food technologies. It should be noted that any theory of nutrition is necessarily an important part of trophology [5]. The purpose of the article is to systematize the main concepts of nutrition theories using a trophological approach to substantiate new solutions to issues and challenges related to improvement of nutrition.

In general the evolution of views on the principles of nutrition is presented below in the form of a diagram (Figure 1) [5,18,19].

**Basic concepts of nutrition theories**

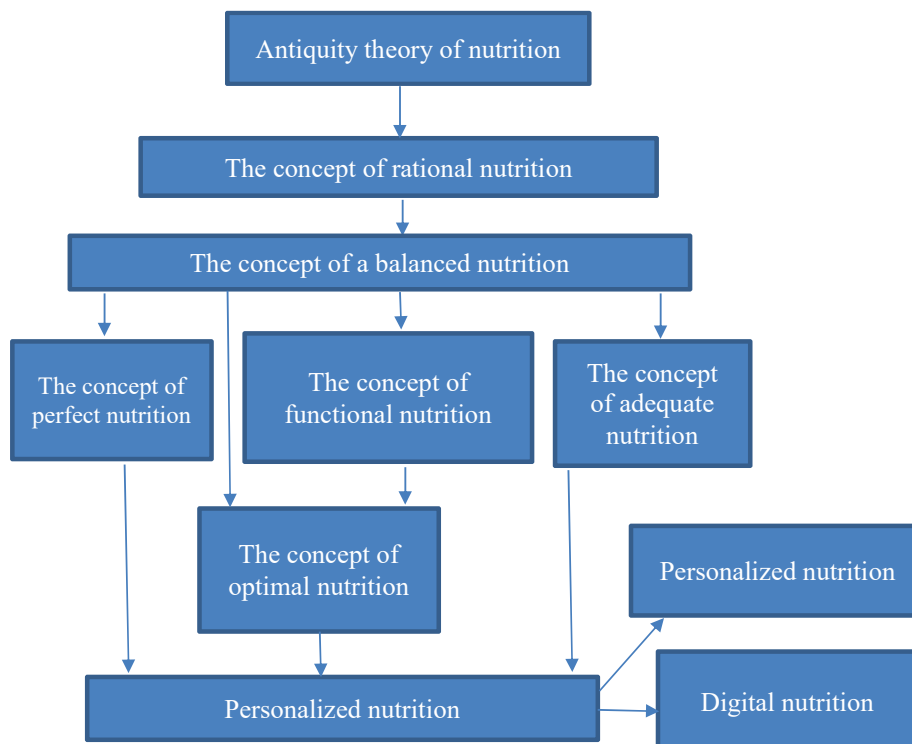
The very first theory of nutrition arose far back in antiquity and was associated with the names of Aristotle and Galen. According to the antique theory, the body is nourished by blood, which is continuously formed from the consumed food substances as a result of some kind of fermentation-type process. In the liver, the blood is purified and then used to nourish organs and tissues. Thus, using our modern terminology, digestion was originally viewed as the process of transforming nutrients into other substances that serve as a source of energy for body and components for tissue building. On this basis, numerous therapeutic diets were created, thus providing an easier conversion of nutrients into the blood [4,5].

The concept of rational nutrition was formulated in 1930 by Professor M. N. Shaternikov in the following form: “In the dynamics of life processes the dominant role belongs to the exchange of substances and forces between the human organism and the external environment. That is the nutrition processes in the broad sense of the word. Growth, development, working capacity and even the very existence of a human being and animals is dramatically dependent on the sufficiency and rationality of nutrition. In other words, the theoretical basis for the development of nutritional standards should be the study of the state of metabolism in the body, depending on the quantity and quality of nutrients consumed by a person [4, 5].

The concept of a balanced diet was set forth in 1964 by academician A. A. Pokrovsky. It is based on six basic postulates as follows (Figure 2) [5,20].

The theory of balanced nutrition enabled to scientifically substantiate the norms of nutrient intake, as well as to overcome many nutritional defects and diseases associated with a lack of vitamins, lack or shortage of essential amino acids, fatty acids, and trace elements. On its basis, various food rations have been created for all groups of the population, taking into consideration the level of their physical activity, environmental climate and other living conditions. All industrial, agro technical and medical measures are based on this theory, which come down to the fact that the improvement of the properties of food products can be achieved by extracting nutrients against the background of a decrease in ballast substances [4,5,20].

However, the balanced approach and the resulting idea of refined, artificially enhanced, ballast-free food also brought significant harm to health. Researchers began to record a surge of diseases — atherosclerosis, diabetes,



**Figure 1.** The evolution of views on human nutrition

- 1) nutrition maintains the molecular composition of a body and compensates for its energy consumption and plastic needs;
- 2) nutrition is considered to be perfect when the intake of food substances is maximally adequate (in terms of time of consumption and composition of food) to their consumption;
- 3) the intake of nutrients into the blood is ensured as a result of the destruction of food structures, digestion and absorption of nutrients necessary for metabolism, energy and plastic needs of the body;
- 4) food consists of several components, different in physiological significance — nutrients, ballast substances and harmful (toxic substances);
- 5) the value of a food product is determined by the content and ratio of amino acids, monosaccharides, fatty acids, vitamins and some salts in it;
- 6) food is digested by a body

**Figure 2.** The main postulates of a balanced diet concept

osteocondrosis, osteoarthritis, etc. The production of refined, highly-purified food products turned into emerging of gastrointestinal tract diseases. The dietary regime happened to be no less important. One or two meals a day entailed not only a partial loss of food due to the difficulty of digesting a large amount of food per one intake, but also contributed to emerging of dramatically profound metabolic disorders [4,5,20].

Thus, the main drawback of this theory of nutrition is ignoring the role of dietary fiber and other factors that are not related to nutrients. The theory of balanced nutrition has been re-evaluated. The crisis of this theory stimulated

a new scientific research in the field of physiology of digestion, biochemistry of food and microbiology [4,5,20]. All this led to the emergence of a new theory of adequate nutrition. It included every valuable element from the theory of balanced nutrition, but new provisions also appeared [4,5].

In the 80s of the 20<sup>th</sup> century the Russian physiologist academician A. M. Ugolev formulated the theory of adequate nutrition, which is actually a development of the theory of balanced nutrition, taking into account the latest data on the role of dietary fiber and intestinal microflora in physiology of nutrition [4,5]. The concept of adequate nutrition is based on six basic postulates as follows (Figure 3):

1. Nutrition maintains the molecular composition and compensates for the energy and plastic costs of the body for basic metabolism, external work and growth (this postulate is the only one common to the theories of balanced and adequate nutrition).
2. Normal nutrition is not due to a single flow of nutrients from the gastrointestinal tract into the internal environment of the body, but to several flows of nutritional and regulatory substances that are of vital importance.
3. The necessary components of food are not only nutrients, but also ballast substances.
4. In metabolic and especially trophic terms, the assimilating organism is a supraorganismal system.
5. There is an endoecology of the host organism, formed by the intestinal microflora, with which the host organism maintains a complex symbiotic relationship, as well as the intestinal, or enteral, environment.
6. The balance of nutrients in the body is achieved as a result of the release of nutrients from food structures during the enzymatic breakdown of its macromolecules due to cavitary and membrane digestion, and in some cases intracellular (primary nutrients), as well as due to the synthesis of new substances, including essential ones, by bacterial flora intestines (secondary nutrients). The relative role of primary and secondary nutrients varies widely.

**Figure 3.** The main postulates of the theory of adequate nutrition

The concept of perfect nutrition is theoretically based on the apparent observance of the laws of nutrition, and in a generalized form it was proposed in 1991 by academician A. M. Ugolev [4]. The main postulate of this concept is as follows: nutrition is primarily a process of maintaining and balancing the molecular composition of a body, i. e. the process of compensating of losses that occur in the body. This concept served as the basis for development of the so-called elemental nutrition, which expediency was not confirmed during the tests [5].

The concept of optimal nutrition is a derivative of the concept of balanced nutrition. This concept converts the recommended norms for energy consumption and nutrient requirements from group values to individual values [5].

Thus, according to the provisions of previous concepts, food was considered mainly as a source of energy and nutrients. Using the deep study of the chemical composition of food raw materials and ready food products and the identification of correlations between the content of individual micronutrients and biologically active substances, as well as the state of public health, a new view of food was formulated as a means of preventing and curing certain diseases.

The concept of functional (healthy, positive) nutrition was first formulated in the early 1980s in Japan [21]. The term “functional nutrition” implies the foods which in case of systematical consuming, benefit human health, increase its resistance to diseases, and can improve many physiological processes in the body, thus allowing a person to maintain an active lifestyle for a long time. Positive nutrition food contains ingredients that provide them with functional properties: dietary fiber, oligosaccharides, amino acids, peptides, polyunsaturated fatty acids, vitamins, antioxidants, minerals, bifid bacteria, and others elements [22,23].

Healthy food products are not medicines and cannot cure; but they help prevent diseases and aging of the body in the current environmental situation. The place of functional nutrition is defined by researchers as an average between the usual way of nutrition, when a person eats what he wants in order to satiate, and the therapeutic nutrition assigned for sick people [22, 24–27].

The basic idea behind perfect food and perfect nutrition is to achieve the best possible manifestation of all the capabilities of the body and its optimal functioning. However, this goal appears to be unrealistic. In fact, some types of food are favorable for high physical exertion, in the same cases where there are significant psychological stresses, a different diet is needed. Moreover, emotional background changes also require corresponding changes in the diet. The types of nutrition in hot and cold climates also differ significantly, and the differences in the nutrition of North and South peoples cannot be reduced down to economic factors only [28]. Finally, to increase life expectancy, low-calorie diets are recommended. At the same time, intensive work requires a sufficiently high level of nutrition. Thus, there are a number of patterns of adequate food and nutrition for different conditions. But none of them are completely perfect [5, 29–33].

First of all modern perfect nutrition is the nutrition of an individual that takes into consideration his/her age, type of build, major and side diseases. That is the personalized nutrition [5, 29, 30, 34–36].

Personalized nutrition is a scientific approach to the individual health of each person. In order to make a person's nutrition really correspond to his personal characteristics, it is necessary to constantly collect and process a large amount of information about his/her body, condition and habits. The study of personalized nutrition is engaged in the science of nutrition [34–37].

Nutrition in its most generalized form can be defined as a part of biology that studies human nutrition and human development, taking into account the conditions and the environment [37]. Nutrition is one of the intensively developing sciences of an integrative nature.

The integration of nutrition with engineering sciences, in particular with food technology, opens up the development of new modern digital methods and techniques for developing products with a specified chemical composition, specialized products, as well as the food for personalizing of diets [18,19].

Today the phenomenon of the emergence of a new scientific direction of “digital nutrition” is being considered, which direction provides for the digital transformation of data on the physiological needs of a person for food, biological substances and energy, as well as the chemical composition of basic foods. It became possible to create software for the development of personalized diets both for a healthy diet and for the prevention and treatment of alimentary-dependent diseases [18,19,38].

It should be noted that merely sufficient food production does not ensure the optimal level of human health. Conscious high culture of food is necessary. Moreover, it is necessary to provide more comprehensive culture, which should be called trophological. In addition to the culture of nutrition the food culture should include the culture of food production (including agriculture, ecology, industrial technology), food distribution and storage. Food culture is a consciously organized, possibly more optimal (adequate) satisfaction of nutritional needs based on achievements of trophology, humanity within the limits of economy and ecology [5,29,30].

The term “trophological culture” means the understanding and using the basic laws of metabolism and nutrition patterns in the daily life of each person and society as a whole. That can ensure the optimal functioning of a body, taking into consideration the actual conditions of life, climate, work, etc. The trophological culture of nutrition includes an understanding not only of the rules of food consumption, but also of all stages of work on food products in agriculture and the food industry (at food industry enterprises) and, of course, in trade. Trophological culture can only be based on the scientific approaches that allow not only justify the correct consumption of food, but also define food production, processing, storage and distribution. Food culture is part of trophology. This is true,



since without a certain level of food culture it is extremely difficult to solve a number of global problems, including the problem of defeating hunger and many diseases (atherosclerosis, cardiovascular diseases, certain malignant neoplasms, diabetes, gastrointestinal tract disorders, food allergies and many others), as well as the problem of struggling against aging of a body [4,5,29–31].

**Food allergen management concept**

One of the major nutritional problems of the modern world is food allergy, which affects approximately 3 to 10% of adults and 8% of children worldwide [39]. Food allergens affect the health and quality of life of people with hypersensitivity caused by some food components, and such allergens are considered to be serious threat to food safety [40]. To reduce the risk of adverse allergic reactions in food consumers it's necessary to put out certain food allergens from the diet [41,42]. However, the elimination diet like this won't be efficient if food manufacturers fail to inform their consumers reliably on the presence of allergens in food.

The concept of managing food allergens as a food safety threat emerged in the last decade of the 20<sup>th</sup> century and since then has expanded significantly. Food allergens management has been evolving along with increasing knowledge and understanding of this issue. Initially, little was known about key determinants of risk, such as sensitivity and speed of an allergic reaction in susceptible individuals in response to an allergen. There was virtually no information on the number of affected consumers, even for the most studied allergenic foods such as peanuts [43–47].

As you know, today there is no cure for allergies that guarantees a complete recovery. Until an effective treat-

ment for food allergy becomes available, sensitive consumers should avoid food allergens to prevent an allergic reaction [48]. Successful prevention of consumption of allergenic substances by food allergic people depends on availability of reliable information among the population about the content of allergens in certain food products. In a number of countries, regulations have been adopted that regulate the requirements for labeling food products containing allergens. Since more than 200 products have been shown to cause allergic reactions in sensitive individuals, regulators in many countries have acknowledged the need to develop labeling rules for food products containing priority allergens. The priority allergens are able to cause the most severe allergic reactions that can lead to significant harm to health and even to death (Figure 3).

In the Russian Federation, the requirements for labeling of food products containing allergenic ingredients are set forth in TR TS022/2011 “Food products in part of their labeling”<sup>1</sup>.

In 2020 TC226 “Meat and meat food products” developed the first edition of the draft national standard “Meat industry: procedure for developing an allergen management program”, which establishes the procedure for developing a program of food allergen management, provides the general requirements for arrangement and running the allergen management process, describes the method of recording the results of this activity, and method of their analysis at the enterprises of the meat processing industry (Figure 4).

<sup>1</sup> Technical regulations of the Customs Union TR CU022/2011 “Food products in terms of its labeling” (Adopted by The decision of the Council of the Eurasian economic Commission of December 9, 2011 № 881). Moscow, 2011. Retrieved from <https://docs.cntd.ru/document/902320347>. Accessed May 24, 2021 (In Russian)



**Figure 4.** Documents defining the requirements for allergens management, applicable in the Russian Federation and the EU

### Nutrition Development Legislation

Today, the practical implementation of the trophological approach in the concepts and theories of nutrition is recorded in legislative documents. The strategy for the formation of a healthy lifestyle of the population, the prevention and control of non-communicable diseases for the period up to 2025<sup>2</sup>, sets out the goals, objectives and principles of the state policy of the Russian Federation in the sphere of public health. This state policy is aimed at ensuring the national interests and implementing national long term strategic priorities in the sphere of promoting a healthy lifestyle and prevention of spread of non-communicable diseases among the population of the Russian Federation. The legal basis of the strategy is set forth in a range of documents, one of which is the Decree of the Government of the Russian Federation dated from October 25, 2010 No. 1873-r, which defines the foundations of the state policy of the Russian Federation in the sphere of healthy nutrition for the population (Figure 5).

<sup>2</sup> Strategy for the formation of a healthy lifestyle of the population, prevention and control of non-communicable diseases for the period up to 2025. (Order of the Ministry of Health of Russia No. 8 dated February 15, 2020). Retrieved from <https://docs.cntd.ru/document/564215449> Accessed September 19, 2022. (In Russian).

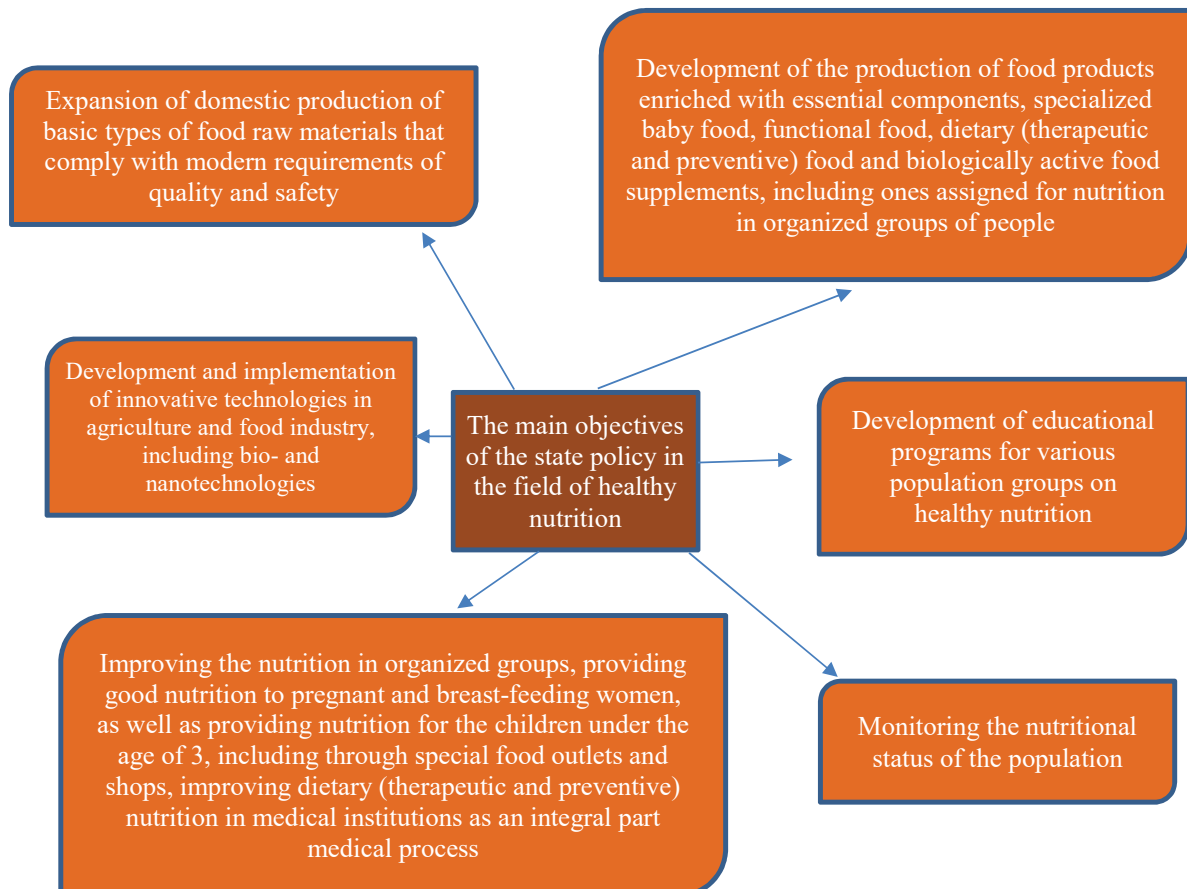
### Conclusion

According to the requirements of the state policy of the Russian Federation in the sphere of healthy nutrition for the population, the modern scientific approaches to the development of nutrition and food products designing are based on the fundamental principles of rational nutrition, reflected in the basic concepts of nutrition theories.

Taking into consideration all of the above specified, it should be noted that each theory of nutrition makes an important part of trophology and significantly affects a number of criteria for this science.

Trophology provides an opportunity to solve applied problems, which include the issues of perfect food and optimal nutrition in real terms; include development of new criteria for technologies of food production and storage; deal with protection and conservation of natural trophic ecosystems based on trophological analysis; ensure harmonization of natural and industrial food technologies.

The trophological approach in personalized nutrition is a new scientific direction to ensure the normal development of a human body and its vital activity. Individual nutrition is a necessity of today, which sets the task for food industry enterprises to create the food products, food complexes and components that will satisfy not only the basic needs of an individual organism, but will also contribute to the regulation of metabolism in order to preserve and develop the potential of a human body.



**Figure 5.** The main objectives of the state policy in the sphere of healthy nutrition

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