



## **THEORY OF BALANCED NUTRITION AND HEALTH**

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### **ABSTRACT**

*It goes without saying that nutrition is a central issue and a matter of constant concern for humanity. Perhaps the greatest misconception is the belief that the problem of proper human nutrition can be solved simply by producing a sufficient quantity of essential food products. In its modern form, the theory of balanced nutrition is less a single theory than a paradigm—that is, a complex of theories, methods, and modes of thought. It stands as one of the finest creations of the human mind and one of its greatest achievements in terms of both practical and humanistic implications.*

**Introduction.** An objective analysis shows that the free choice of such products in modern human society in most cases leads to nutritional disorders, which, depending on many genetic and phenotypic characteristics of a person, provoke the development of a number of serious diseases (Table 1).

In the history of science, two main theories of nutrition are known. The first arose in ancient times; the second—the classical theory, often referred to as the theory of balanced nutrition—emerged over two hundred years ago. The second theory, which is currently dominant, replaced the classical theory and is one of the remarkable achievements of experimental biology and medicine.



**Table 1. Syndromes associated primarily with eating disorders (according to: Haenel, 1979, with additions)**

| <b>Overnutrition</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| carbohydrates, refined starch and sugars                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | proteins                                                                                                                                                                                              |
| <b>Diseases, disorders</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                       |
| Cardiovascular diseases<br>(hypertension, atherosclerosis,<br>varicose veins, thrombosis)<br>Chronic bronchitis,<br>pulmonary emphysema<br>Diseases of the<br>gastrointestinal tract (ulcers,<br>gastritis, enteritis, ulcerative<br>colitis, hemorrhoids)<br>Appendicitis, cholecystitis,<br>pyelonephritis caused by<br>intestinal<br>stick cholecystitis<br>Gallstone disease<br>Kidney stone disease<br>Diabetes<br>Hyperlipidemia<br>Toxicosis of pregnancy<br>Epilepsy, depression<br>Multiple sclerosis<br>Periodontosis | Cardiovascular diseases<br>(myocardial infarction,<br>hypertension, atherosclerosis,<br>thrombophlebitis, embolism,<br>microangiopathy)<br>Diabetes<br>Hypercholesterolemia<br>Toxicosis of pregnancy |
| <b>Prevention</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                       |
| Reducing the consumption of easily digestible and refined carbohydrates                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Reducing protein intake                                                                                                                                                                               |

### **Ancient nutrition theory**

The ancient theory is associated with Aristotle and Galen. According to this theory, the body is nourished by blood, which is continuously formed from nutrients through a complex process of unknown origin, similar to fermentation. In the liver, the blood is purified and then used to nourish organs and tissues. Thus, using modern terminology, predigestion was viewed as the



process of transforming nutrients into other substances that serve as a source of energy and building blocks.

### **1. The main postulates of the theory of balanced nutrition**

The theory of balanced nutrition arose alongside classical experimental natural science and, in essence, remains the dominant worldview today. The foundations of this theory are set forth in a number of textbooks in various fields of biology and medicine. Various aspects of the theory of balanced nutrition are discussed, in particular, in the following summaries: Sherman , 1937; Winitz et al ., 1970; Therapeutic nutrition, 1971; Chemical and physiological problems..., 1972, 1975, 1976; Pokrovsky, 1974, 1979; Haenel, 1979; Samsonov, Meshcheryakova, 1979; Harrison et al ., 1979; Protein metabolism..., 1980; Parks , 1982; Petrovsky, 1982; Le Magnen , 1983; Kanevsky et al., 1984; Konyshch, 1985, 1990; Field, 1985; Heusner, 1985; Ugolev, 1985, 1987a; Emmanuel, Zaikov, 1986, and others. We will focus our attention on some issues that are less often seen, although they are extremely important for understanding the essence of the classical theory.

Classical nutrition theory is thoroughly modern, meeting contemporary criteria and playing a crucial role in the progress of a number of sciences and technologies. It first began to take shape when it became clear that ancient models of blood circulation and digestion were incorrect and needed to be replaced: the former by the doctrine of blood circulation, originally proposed by William Harvey in 1628 and refuting the ideas prevalent in Galen's time, and the latter by new concepts of digestion developed by R. Reaumur and L. Spallanzani. The latter was particularly important, as the idea of preparing bodily fluids from food was replaced by a fundamentally new concept of breaking down food into elements, some of which (the actual nutrients) were assimilated, that is, incorporated into the body, while others (the waste) were discarded. It is no exaggeration to say that this idea marked a turning point in views on the nature of nutrition and its disorders, as well as on industrial technologies related to food in one way or another.

The classical theory of balanced nutrition, based on the work of R. Réaumur, L. Spallanzani, A. Lavoisier, G. Helmholtz, and others, was finally established in the late 19th and early 20th centuries. Associated with this theory are concepts of ideal food and optimal balanced nutrition, which were based on balanced approaches to nutritional assessment and management, and which remain relevant today.

The classical theory of balanced nutrition can be reduced to several fundamental postulates:

- 1) nutrition maintains the molecular composition of the body and compensates for its energy and plastic expenditure;
- 2) The ideal diet is one in which the intake of nutrients corresponds as closely as possible (in terms of time and composition) to their consumption;
- 3) the entry of nutrients into the blood is ensured by the destruction of food structures and the absorption of nutrients necessary for metabolism, energy and plastic needs of the body;



4) food consists of several components, different in physiological significance – nutrients, dietary fiber (from which it can be purified) 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;

b) food is utilized by the body itself.

Let us consider some of these postulates, as well as a number of consequences arising from the theory of balanced nutrition, in more detail.

**Laws of conservation of the constancy of the molecular composition of the organism and nutrition.** In his work on the main developments in the biological sciences in the 19th century, I. M. Sechenov wrote that the classical theory of nutrition is based on the fundamental laws of conservation of matter and energy in relation to biological systems. When applied to living organisms, one could also speak of the law of conservation of their molecular composition.

The balanced approach assumes that nutrients entering the body must compensate for losses associated with basal metabolism, external work, and, for young organisms, also with growth. In other words, the theory of balanced nutrition is based on the premise that the body should receive a set of nutrients that compensates for those expended on building body structures and performing work (see Tables 1 and 2). Consequently, the balanced approach is associated with maintaining the constancy of the molecular composition of living systems.

**Table 2. Average adult nutritional requirements according to the balanced diet formula (based on: Pokrovsky, 1974)**

|                                                 |                  |
|-------------------------------------------------|------------------|
| <b>Water (ml)</b>                               | <b>1750–2200</b> |
| including:<br>drinking water, tea, coffee, etc. | 800–1000         |
| soups                                           | 250–500          |
| Power supply options                            | 700              |
| <b>Proteins ( )g</b>                            | <b>80–100</b>    |
| including animals                               | 50               |
| <b>Essential amino acids (g)</b>                |                  |
| tryptophan                                      | 1                |
| leucine                                         | 4–6              |
| isoleucine                                      | 3–4              |
| valine                                          | 3–4              |
| threonine                                       | 2–3              |
| lysine                                          | 3–5              |
| methionine                                      | 2–4              |
| phenylalanine                                   | 2–4              |



| <b>Replaceable amino acids ( )g</b> |             |
|-------------------------------------|-------------|
| histidine                           |             |
| arginine                            | 15-2<br>5-6 |

|                                       |                |
|---------------------------------------|----------------|
| cystine                               | 2-3            |
| tyrosine                              | 3-4            |
| alanine                               | 3              |
| serine                                | 3              |
| glutamic acid                         | 16             |
| aspartic acid                         | 6              |
| proline                               | 5              |
| glycol                                | 3              |
| <b>Carbohydrates (g)</b>              | <b>400-500</b> |
| including:<br>starch                  | 400-450        |
| sugar                                 | 50-100         |
| <b>Organic acids ( )g</b>             |                |
| including:<br>lemon, milk, etc.       | 2              |
| <b>Ballast substances (g)</b>         |                |
| fiber, pectin, etc.                   | 25             |
| <b>Fats (g)</b>                       | <b>80-100</b>  |
| including: plant-based                | 20-25          |
| essential polyunsaturated fatty acids | 2-3            |
| cholesterol                           | 0.3-0.06       |
| phospholipids                         | 5              |
| <b>Minerals (mg)</b>                  |                |
| calcium                               | 800-1000       |
| phosphorus ro                         | 1000-1500      |

|               |           |
|---------------|-----------|
| sodium        | 4000-6000 |
| potassium     | 2500-5000 |
| chlorine di y | 5000-7000 |
| magnesium     | 300-500   |
| iron          | 15        |
| zinc          | 10-15     |
| manganese     | 5-10      |



|                                 |                                                                                              |
|---------------------------------|----------------------------------------------------------------------------------------------|
| chromium                        | 0.1                                                                                          |
| copper                          | 0.1                                                                                          |
| cobalt                          |                                                                                              |
| molybdenum                      | $\frac{2-2,5}{2}$<br>$\frac{0,1-0,2}{0,5}$<br>$\frac{0,5}{0,5}$<br>$\frac{0,5-1,0}{0,1-0,2}$ |
| selenium                        |                                                                                              |
| fluorine di y                   |                                                                                              |
| iodine di y                     |                                                                                              |
| <b>Vitamins (mg)</b>            |                                                                                              |
| ascorbic acid (C)               | 50–70                                                                                        |
| thiamine ( B <sub>1</sub> )     | 1.5–2.0                                                                                      |
| riboflavin ( B <sub>2</sub> )   | 2.0–2.5                                                                                      |
| niacin (PP)                     | 15–25                                                                                        |
| pantothenate ( B <sub>3</sub> ) | 5–10                                                                                         |
| pyridoxine (B <sub>6</sub> )    | 2–3                                                                                          |

|                              |                                                                                                                                |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| cobalamin (B <sub>12</sub> ) | 0.002–0.005                                                                                                                    |
| biotin                       |                                                                                                                                |
| choline                      | $\frac{0,15-0,30}{500-1000}$                                                                                                   |
| rutin ( )R                   | 25                                                                                                                             |
| folacin (B <sub>9</sub> )    | 0.2–0.4                                                                                                                        |
| Vitamin D (various forms )   |                                                                                                                                |
| Vitamin A (various forms )   |                                                                                                                                |
| carotenes                    |                                                                                                                                |
| Vitamin E (various forms )   | $\frac{0,0025-0,1 (100-400 ME)}{1,5-2,5}$<br>$\frac{3,0-5,0}{10-20 (5-30)}$<br>$\frac{0,2-0,3}{0,5}$<br>$\frac{0,5-1,0}{3000}$ |
| Vitamin K (various forms )   |                                                                                                                                |
| lipoic acid                  |                                                                                                                                |
| inositol ( )g                |                                                                                                                                |
| <b>Total calories (kcal)</b> |                                                                                                                                |



Interestingly, the idea of homeostasis was most clearly formulated by those scientists who experimentally studied the processes of digestion and nutrition. In this regard, Claude Bernard and I.P. Pavlov are particularly noteworthy.

Thus, the classical theory is based on the idea that nutrition serves to maintain the body's molecular composition at a certain physiological level, or, more precisely, within a certain physiological range. This involves compensating for energy and plastic losses, as well as growth-related needs.

For the theory of balanced nutrition, it is important that food consists of several main components, different in their biological significance:

- 1) actual nutrients – proteins, carbohydrates, fats, vitamins, etc.
- 2) ballast substances;
- 3) harmful (toxic) compounds.

If the valuable part of food is the nutrients needed for metabolism, then food can be purified from ballast according to classical theory.

The classical theory of balanced nutrition, at least at a relatively advanced level, allowed us to answer questions about the ideal food and the minimum adequate diet, as well as what food deficiencies, and to what extent, would affect bodily functions or be incompatible with life. Indeed, a defective food, consisting of a set of substances lacking certain essential components, could cause illness and even death in experimental animals. On the other hand, an artificial diet, characterized as complete in light of the theory of balanced nutrition, could indefinitely support the life of not only the individual but also its offspring. However, as will be shown below, this approach to food composition contained errors that would seem obvious to an objective observer if they adopted the new theory of adequate nutrition.

**The main consequences of the theory of balanced nutrition.** Logical clarity and experimental validity, but also for its ability to predict unknown phenomena that were subsequently discovered, or patterns that could be, and indeed were, discovered under specific experimental conditions. Knowing the essential nutrients, it is possible to design diets sufficient for the survival, normal functioning, and development of organisms. If any disturbances arise, as postulated by the theory of balanced nutrition, the defect must be attributed to a deficiency of one or more essential nutritional factors. It was in this manner that vitamins, microelements, essential amino acids, and other essential nutrients were discovered one after another. In particular, it was demonstrated that approximately half of the 20 amino acids that make up proteins are essential for certain metabolic functions. The number of essential amino acids varies from 10 to 13 depending on the animal species, its diet, etc. For example, humans have 10 essential amino acids, rats and chickens have 13, and the average animal has 12. However, organisms of all species have 8–9 essential amino acids in common. Interestingly, in chickens, at least three of the 13 essential amino acids (tyrosine, cystine, and hydroxylysine) can only be synthesized with a limited supply of dietary substrates.



According to this theory, not all components of food are necessary to support the body's vital functions, but only the beneficial ones. By concentrating them, one can create so-called fortified foods.

Based on this idea, it was possible to increase the proportion of nutrients in food and improve the ratio between them, bringing it closer to the ideal. (By the ideal nutrient ratio, most researchers understood the ratio of incoming nutrients that would best meet the body's energy and plastic needs.)

## **2. Ideal nutrition, elemental, parenteral nutrition**

One of the ideas stemming from the theory of balanced nutrition is the creation of ideal food and ideal nutrition. In the late 19th and early 20th centuries, the basic concept of improving food and nutrition emerged. Thus, as early as the 19th century, the idea of creating the most improved food by enriching foods with substances directly involved in metabolism and eliminating unnecessary fiber emerged.

**Elemental nutrition.** By the late 19th and early 20th centuries, the idea of creating an ideal, maximally nutritious food had already transformed into the idea of constructing a mixture of substances essential to sustaining life and not requiring optimal ratios—that is, the idea of creating so-called elemental, or monomeric, substances. The idea of elemental nutrition boiled down to the idea that the oligo- and polymeric foods we consume should be replaced with foods composed of elements involved in metabolism. This food should consist of a set of amino acids, monosaccharides, fatty acids, vitamins, salts, etc. It was assumed that such food would satisfy human needs in precise accordance with the specific characteristics of our metabolism.

**Parenteral nutrition.** A consequence of the theory of balanced nutrition is the idea, vividly formulated back in 1908 by P.-E.-M. Berthelot, that one of the main tasks of the twentieth century is the direct introduction of nutrients into the blood, bypassing the gastrointestinal tract. Currently, direct (intravascular or parenteral) nutrition has become a widespread and highly effective means of directly introducing nutrients into the blood, used in the treatment of various diseases over fairly long periods of time. In particular, the review by P.S. Vasiliev (1988) provides characteristics of a number of specialized mixtures used in clinical practice for parenteral nutrition, and highlights their positive role in the correction of various diseases (metabolic disorders, in particular protein; various injuries, including burns; gastrointestinal tract disorders, in particular surgical interventions; oncological diseases; pathology of the liver, kidneys and a number of others).

## **3. Advantages and disadvantages of the balanced nutrition theory**

The theory is distinguished by the rigor and consistency of its axiomatics. It underlies all modern nutritional concepts and has allowed for a scientific explanation of dietary requirements for energy, nutritional value, and other components.

The theory of balanced nutrition has served as the foundation of modern food technology and enabled the development of practical measures related to food resources and nutrition. It



underpins industrial, agricultural, and medical developments, which rely heavily on the idea that improved nutritional properties can be achieved by increasing nutrient content while reducing the proportion of waste.

Classical theory views the alimentary tract as a near-perfect chemical plant, operating under less-than-ideal conditions due to certain raw material defects (e.g., food contamination) and the presence of bacteria in the gastrointestinal tract. At the same time, specialized systems exist that provide protection against bacterial competition for nutrients, bacterial penetration into the body's internal environment, the toxic effects of bacteria, and invasions. The new theory of adequate nutrition has gradually developed the idea that bacterial flora plays a dual role: on the one hand, as a competitor for nutrients and a potential pathogen, and on the other, as an important symbiont and supplier of secondary nutrients.

Among the fundamental shortcomings of the classical theory is its anthropocentric nature, that is, its focus on solving practical problems of human nutrition, or more precisely, the problems of rational human nutrition in conditions where people themselves are unable to clearly determine their dietary needs. In other words, this theory is insufficiently biological and evolutionary. Interestingly, classical nutrition theory fails to explain the dramatic differences in the composition of diets traditionally consumed by populations in different climatic zones. For example, a rational diet based on the theory of balanced nutrition and suitable for Europeans cannot always be used for the nutrition of northern peoples, whose diet consists primarily of meat, fat, and fish. Nevertheless, this diet does not cause any harmful consequences. Even more surprising is the predominantly plant-based diet of the majority of the inhabitants of India and many African tribes. In the latter's diet, the total protein content does not exceed 5-8%. Equally striking are the differences in mineral consumption among different peoples. (In this case, we are considering the body's physiological needs for the corresponding salts.)

The classical theory is also unsuitable for explaining the regulation of nutrition in most groups of organisms with different types of nutrition and with different mechanisms of food processing based on the principles of self-regulation.

Thus, during the period of the theory's greatest success, a crisis intensified, leading to the development of a new theory of nutrition, which we call the theory of adequate nutrition. It has now been demonstrated that this theory can solve a number of difficult theoretical and applied problems that traditional approaches were unable to address.

**Conclusions.** This chapter briefly reviewed the classical theory of nutrition, often referred to as the balanced diet theory. This theory was shaped from the outset as anthropocentric, and many important biological and evolutionary approaches of general significance were overlooked and not taken into account.



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