

# ENERGY EXPENDITURE CONSIDERATIONS IN THE CONTROL AND TREATMENT OF OVERWEIGHTNESS AND OBESITY.

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## **Introduction.**

*Energy is a universal property of living and non-living matter. It is the most important component of Nature (everything that objectively exists) and is a measure of a system's ability to perform work, either within itself or upon the environment outside its own boundary (1-3). Fig 1.*

**ENVIRONMENT (E)**

**SYSTEM (s)**

**BOUNDARY (B)**

**Fig. 1. Diagram of a system.**

*Systems may or may not be thermodynamic. Thermodynamic systems are made up of a very large (immeasurable) number of atoms, molecules, or particles and may be classified into three groups: closed, isolated, and open (4-6). Fig. 2 and Fig. 3.*

**E**

**s**

**B**

**Fig. 2. Diagram of a thermodynamic system.**

*Closed thermodynamic systems do not exchange energy (e), work (w), chemical substances (ch), or information (i) with the environment outside their boundaries.*

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Isolated systems only exchange energy or work, whereas open systems may exchange all of these elements (5,6).

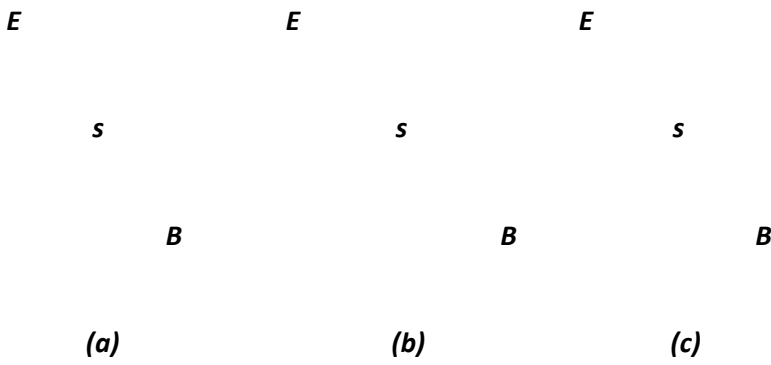


Fig. 3. Diagram of closed (a), isolated (b), and open (c) thermodynamic systems.

The cell is the basic structural and functional unit of every living system or organism, and is also an open thermodynamic system (1,7).

**METABOLIC FUNCTION.**

A biological function can be defined as any manifestation of living activity. The most important of these biological functions is the metabolic function, also known as metabolism, and it is impossible to talk about life without referring to it (8).

Metabolism is simply a set of chemical reactions that occurs in a biosystem within a specific period of time. It is the most important biological function, because as it occurs, it creates the energy movement necessary to perform the many types of life-sustaining work that facilitate communication and other necessary interactions between the components of a living organism and between the organism itself and its external environment (1,7-9).

Metabolic function is supplied and sustained by the nutrients that make up the different types of chemical substances in food that form an individual's diet, in other words, the chemicals necessary to sustain the proper structure and function of all the constituent parts of a cell (1,10).

**TYPES OF NUTRITIONAL AND FOOD CHEMICAL SUBSTANCES.**

Food chemicals fall into two categories: energetic and non-energetic. Neutral fats, or triglycerides, which release 9.0 kcal/g when oxidized; homopolysaccharides or starch (a complex carbohydrate) and the heteropolysaccharides (disaccharides) sucrose and lactose (which release about 4.0 kcal/g when oxidized), and proteins

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(4.0 kcal/g when oxidized) are considered energetic food chemicals. Polynucleotides, deoxyribonucleic acid (DNA), and ribonucleic acid (RNA) are non-energetic food chemicals (1,11).

Oxygen (the most important nutrient for human beings, who have an aerobic metabolism), water, amino acids, monosaccharides, fatty acids, water- and fat-soluble vitamins, minerals, and phytonutrients fall into the category of nutrients.

### **ENERGY EXPENDITURE.**

When cellular, tissue, organ, and body metabolism increases, total energy expenditure increases proportionally. An individual's physical activity, together with his or her resting metabolic rate, food-induced thermogenesis, and adaptive thermogenesis, are all important factors that determine the increase in energy expenditure (12,13).

### **PHYSICAL ACTIVITY.**

Two groups of skeletal striated muscle are invariably involved in any type of physical activity: agonist and antagonist (14).

Both the contractile and relaxation processes in the muscle are active processes; in other words, both require free energy released from the oxidative metabolism in striated muscle—thus the importance of this type of practice in creating a Negative Energy balance, which is fundamental in eliminating fat in the treatment of overweight and in the effective treatment of obesity (15, 16).

### **FRACTIONAL ENERGY EXPENDITURE.**

Physical activity-dependent energy expenditure is integrative or additive; in other words, the amount of heat energy generated by isotonic and isometric muscle contractions of different intensities and durations, performed at different times and on different muscle groups, are added together in practice. This additive property is useful for increasing the total energy expenditure of individuals who are unable to dedicate large amounts of time to physical exercise—it is through this type of process (fractional physical activity) that they can achieve a higher energy expenditure, even while “on the job” (17, 18).

### **SKELETAL STRIATED MUSCLE.**

Skeletal striated muscle is made up of a finite grouping of highly specialized cells that are able to perform mechanical work by drawing on the chemical potential energy contained as free energy in the biomolecules phosphocreatine and adenosinetriphosphate or ATP, due to the internal isothermal and isobaric conditions of every biosystem (17,19).

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The sarcoplasm found in skeletal muscle cells is a viscous body, in which ten distinct proteins involved in the contractile process have been identified; however, only four of these, namely troponin, tropomyosin, actin G, and myosin, are directly related to the process, together with the calcium ion. The process of muscular relaxation is similar (20,21).

Most of the free energy used in both contraction and relaxation of striated muscle cells is ultimately converted into heat energy, which in turn reduces the natural viscosity of the sarcoplasm as well as the phosphocreatine and ATP energy required to perform work against friction. The contraction-relaxation process is thus optimized, increasing the thermodynamic efficiency of the use of free energy; more simply, muscular activity, especially monotonous or repetitive muscular activity, tends to reduce its total energy expenditure according to the Van't Hoff-Le Chatelier principle (21-23).

In addition, if scheduled changes in rhythm, speed, and force are incorporated into the physical activity of the striated muscle cell open system, thus avoiding optimization of the contraction-relaxation process in the muscle as mentioned above, the result is a net increase in energy expenditure, which is particularly important when considered in relation to the performance of physical exercise used in the treatment of overweight and obesity, together with the concept of "fractional physical activity" and an appropriate quantitative combination of energetic food chemical substances in the diet (24,25).

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**ABSTRACT**

*Energy is defined as the most important component of Nature in its relation to a system's ability to perform work. The cell is identified as the structural and functional unit of every living system and the metabolic function as the most important biological function, which is fed and sustained by nutritional chemical substances. The different components of energy expenditure and its relation to physical activity are analyzed. The concept of fractional physical activity is defined as a possible procedure for increasing the body's total energy expenditure based on the integrative or additive characteristics of this type of activity. Functional details of skeletal striated muscle and its constituting cells are described.*

*It is concluded that fractional physical activity, planned changes in the rhythm, speed, and force of the contraction-relaxation process, and a proper quantitative combination of energetic food chemical substances in the diet will facilitate more effective short-term treatment of overweight and obesity.*

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