

## **The milieu intérieur: The Importance of Equilibrium for Our Body**

*Regulating the Organism is Indeed the Central Problem of Physiology*

Walter B. Cannon, 1929

### *Milieu intérieur physiologique*

In 1850, the French physiologist Claude Bernard (1813-1878) postulated that multicellular organisms remain alive because they possess an internal medium capable of maintaining them in relatively uniform conditions, in spite of changes in the exterior environment.

According to Bernard, for an organism to survive it must be partially independent of that environment, which means that the tissues of living beings must be somehow shielded from direct external influences. This protection is provided by a true internal medium that is made up primarily of the liquids that circulate through the body.

Bernard summed up his studies of the higher organisms in his celebrated phrase: “The constancy of the internal medium is the indispensable condition for free life”. He used the term *milieu intérieur physiologique* (internal physiological medium) to refer to the series of chemical substances and processes that constitute an organism, and whose interrelations remain constant despite the variations that may occur in the environment.

This regulating aspect is of extraordinary importance and is considered one of the most important biological generalizations in the history of science. Moreover, the concept of the constancy of the internal medium is one of the fundamental phenomena that have guided the development of physiological research. Physiology cannot be limited to simply providing isolated descriptions of the functions of the body’s different organs and systems, because they must be studied in the broader context of their participation in the common task of maintaining the internal medium.

### **Homeostasis**

In the late 19<sup>th</sup> and early 20<sup>th</sup> centuries, Walter B. Cannon (1871-1945) took Bernard’s approach a step further with his description of the physiological mechanisms that participate in maintaining the body’s essential physical-chemical equilibrium, an idea that

he published in his masterwork, *The Wisdom of the Body* (1932). In 1930, this North American physiologist used the word **homeostasis** –from the Greek *homo*, equal, and *stasis*, standing still– to denote, “The state of equilibrium in which the internal corporal environment is maintained, owing to the continuous interaction of all the body’s regulatory processes”.

In Cannon’s use of homeostasis it referred to the sum total of the body’s internal, structural and functional constancy. Thus, the term suggests not only the condition of stability in and of itself, but also the innumerable physiological processes required to maintain it. According to Cannon, homeostasis was the key to more highly evolved life forms, and he argued that the degree of evolution of living things was a function of their ability to increase their level of homeostasis.

Therefore, homeostasis constitutes a dynamic condition that responds to changing circumstances. The body’s point of equilibrium can be modified only within the narrow limits that are compatible with maintaining life. For example, the concentration of blood glucose does not normally go below 70 mg per 100 ml of blood, nor rise above 110 mg/100 ml. Each one of the body’s structures, from the cellular level to the systems level, contributes in some way to conserving the internal environment within normal limits. Indeed, maintaining homeostasis requires that many complex processes called homeostatic mechanisms be generated and then triggered in response to some initial change in the internal medium. These reactions are called adaptive responses and they allow the body to adapt to alterations of its environment in such a way as to preserve homeostasis and foster healthy survival.

Homeostasis resides in the corporal liquids located inside and outside the cells. All the substances required for preserving life are dissolved in those fluids, including oxygen, nutrients, proteins and a broad range of electrically charged chemical particles called ions.

The extracellular liquid constitutes one-third of all biological fluids and is made up of the interstitial liquid –either plasma or lymph– that bathes the cells. It constitutes the organism’s internal environment and its usefulness lies in providing the cells with a relatively constant environment and carrying substances to them. The intracellular liquid represents the other two-thirds of all organic liquids and is an excellent solvent that facilitates the chemical reactions necessary for life.

## Beyond the mammals

The concepts introduced by Bernard and Cannon have had an enormous influence on the history of Biology, though many biologists think that they have sometimes been extrapolated and used to excess. Throughout their lives both Bernard and Cannon worked primarily with mammals, an animal group with a particularly high index of internal stability. In contrast, most fish and amphibians do not stabilize their internal temperature through physiological means but, rather, allow it to vary according to the temperature of the external environment. If Bernard and Cannon's models were applied to these classes of animals (indeed, the latter did so), then their lack of internal thermal stability would appear as a defect. In reality, however, it is beneficial because in this way their internal temperature is permitted to come into equilibrium with the external condition, instead of opposing the natural physical tendency towards equilibrium. Thus, their mechanism produces large energy savings. [Reptiles spend large amounts of time under the sun in order to reach the temperature needed for their metabolism to work. Since they do not produce heat, they spend less energy and can subsequently spend more time without eating.](#)

In modern medicine, treating conditions like dehydration, hemorrhages, metabolic imbalances [such as the ones occurring in diabetes mellitus](#) and the many other disorders that so often appear in hospital emergency rooms, intensive care units and simply in doctors' offices, would be unthinkable without this understanding of the physiological phenomena of equilibrium. In fact, so great is the importance of this principal, that it has been applied to the regulation of a variety of ecosystems even to the Universe and as a whole. [The Gaia hypothesis says that homeostasis in earth is maintained by feedback processes operated automatically and unconsciously by the biota.](#)

### Further Readings

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