Homeostasis

- The curse of blood-brain barrier and blood-tumor barrier in malignant brain tumor treatment
- Targeting VSIG4⁺ tissue-resident macrophages enhances T cell cytotoxicity and immunotherapy efficacy in cancer
- MRI-based machine learning reveals proteasome subunit PSMB8-mediated malignant glioma phenotypes through activating TGFBR1/2-SMAD2/3 axis
- Ability of SPP1 to Alleviate Post-Intracerebral Hemorrhage Ferroptosis via Nrf2/HO1 Pathway
- Interleukin-34-dependent perivascular macrophages promote vascular function in the brain
- Ferroptosis in Alzheimer's Disease: The Regulatory Role of Glial Cells
- Matrix Metalloproteinases: Pathophysiologic Implications and Potential Therapeutic Targets in Cardiovascular Disease
- Vagus nerve stimulation as a predictive coding modulator that enhances feedforward over feedback transmission

---

Homeostasis or homoeostasis (homeo- + -stasis) is the property of a system in which variables are regulated so that internal conditions remain stable and relatively constant. Examples of homeostasis include the regulation of temperature and the balance between acidity and alkalinity (pH). It is a process that maintains the stability of the human body's internal environment in response to changes in external conditions.

The concept was described by French physiologist Claude Bernard in 1865 and the word was coined by Walter Bradford Cannon in 1926.

Although the term was originally used to refer to processes within living organisms, it is frequently applied to automatic control systems such as thermostats. Homeostasis requires a sensor to detect changes in the condition to be regulated, an effector mechanism that can vary that condition, and a negative feedback connection between the two.

Since the late 1990s, the idea of homeostasis has evolved. Homeostasis originally referred to the body's ability to maintain stability through internal processes. However, in recent years, the concept has been expanded to include a broader set of dynamics known as “allostatic” processes. Allostasis considers a wider range of factors, such as social, psychological, and environmental influences.

These allostatic dynamics involve the interconnected workings of the brain and body, emphasizing the integration of various causal elements. Additionally, anticipatory mechanisms and top-down controls, provided by internal regulatory models, play a crucial role. These factors were either part of the original descriptions of homeostasis, have been subsequently integrated into the concept, or are related to more general principles of self-organization.

As a result of these developments, the concept of allostasis is now seen as applicable to a larger category of systems found in biology, engineering, and physics. This broader perspective considers advancements in complex systems, statistical mechanics, and the dynamics of heterogeneous systems (such as hierarchical or modular structures), including complex networks in the brain and the internal environment [1)].

The cerebral metabolic rate of oxygen consumption (CMRO2) arises from neurons utilizing energy for two functions:

1) maintenance of cell integrity (homeostasis) which normally accounts for ≈ 40% of energy consumption, and 2) conduction of electrical impulses. The occlusion of an artery produces a central core of ischemic tissue where the CMRO2 is not met. The oxygen deficiency precludes aerobic glycolysis and oxidative phosphorylation. ATP production declines and cell homeostasis cannot be maintained, and within minutes irreversible cell death occurs; a so-called cerebral infarction. Surrounding this central core is the penumbra, where collateral flow (usually through leptomeningeal vessels) provides marginal oxygenation which may impair cellular function without immediate irreversible damage. Cells in the penumbra may remain viable for hours.

Energy homeostasis, food intake, and body weight are regulated by specific brain circuits.

Data support the view that arcuate nucleus (ARC) tyrosine hydroxylase (TH) cells play an unrecognized and influential positive role in energy homeostasis [2)].

Water homeostasis has been shown crucial for regulation of neuronal excitability. The control of water movement is achieved through a family of small integral membrane channel proteins called aquaporins (AQPs). Despite the fact that changes in water homeostasis occur in sclerotic hippocampi of people with temporal lobe epilepsy (TLE) , the expression of AQPs in the epileptic brain is not fully characterised [3)].

Intracranial Pressure Homeostasis

Intracranial Pressure Homeostasis

1)
Bettinger JS, Friston KJ. Conceptual Foundations of Physiological Regulation incorporating the Free Energy Principle and Self-Organized Criticality. Neurosci Biobehav Rev. 2023 Nov 11:105459. doi: 10.1016/j.neubiorev.2023.105459. Epub ahead of print. PMID: 37956880.
2)
Zhang X, van den Pol AN. Hypothalamic arcuate nucleus tyrosine hydroxylase neurons play orexigenic role in energy homeostasis. Nat Neurosci. 2016 Aug 22. doi: 10.1038/nn.4372. [Epub ahead of print] PubMed PMID: 27548245.
3)
Salman MM, Sheilabi MA, Bhattacharyya D, Kitchen P, Conner AC, Bill RM, Woodroofe MN, Conner MT, Princivalle AP. Transcriptome analysis suggests a role for the differential expression of cerebral aquaporins and the MAPK signalling pathway in human temporal lobe epilepsy. Eur J Neurosci. 2017 Jul 17. doi: 10.1111/ejn.13652. [Epub ahead of print] PubMed PMID: 28715131.