Homeostasis Lab Reading

Lesson 3: Homeostasis Lab

Excerpt from *A physiologist's view of homeostasis*

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Homeostatic mechanisms originated to keep a regulated variable in the internal environment within a range of values compatible with life and, as has been more recently suggested, to reduce noise during information transfer in physiological systems. To emphasize the stabilizing process, we distinguish between a "regulated (sensed) variable" and a "nonregulated (controlled) variable". A regulated (sensed) variable is one for which a sensor exists within the system and that is kept within a limited range by physiological mechanisms. For example, blood pressure and body temperature are sensed variables. Baroreceptors and thermoreceptors exist within the system and provide the value of the pressure or temperature to the regulatory mechanism. We call variables that can be changed by the system, but for which sensors do not exist within the system, nonregulated (controlled) variables. Nonregulated variables are manipulated or modulated to achieve regulation of the variable being held constant. For example, heart rate can be changed by the autonomic nervous system to regulate blood pressure, but there are no sensors in the system that measure heart rate directly. Hence, heart rate is a nonregulated variable.

A simple model illustrating the fundamental engineering control system concepts relevant to homeostatic regulatory mechanisms is shown in Figure 1, below.

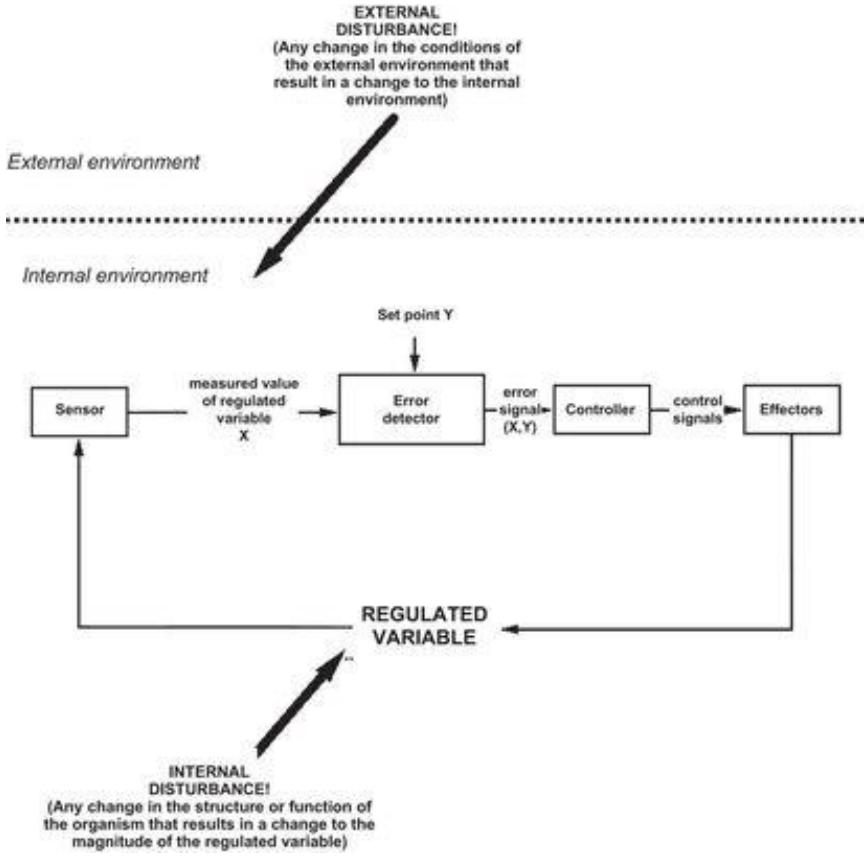

Diagram of a generic homeostatic regulatory system. If the value of the regulated variable is disturbed, this system functions to restore it toward its set point value and, hence, is also referred to as a negative feedback system.

This model, some version of which appears in many current physiology texts, includes the following five critical components that a regulatory system must contain to maintain homeostasis:

1. It must contain a sensor that measures the value of the regulated variable.
2. It must contain a mechanism for establishing the "normal range" of values for the regulated variable. In the model shown in Figure 1, this mechanism is represented by the "set point," although this term is not meant to imply that this normal range is actually a "point" or that it has a fixed value. In the next section, we further discuss the notion of a set point.
3. It must contain an "error detector" that compares the signal being transmitted by the sensor (representing the actual value of the regulated variable) with the set point. The result of this comparison is an error signal that is interpreted by the controller.
4. The controller interprets the error signal and determines the value of the outputs of the effectors.
5. The effectors are those elements that determine the value of the regulated variable.

Such a system operates in a way that causes any change to the regulated variable, a disturbance, to be countered by a change in the effector output to restore the regulated variable toward its set point value. Systems that behave in this way are said to be negative feedback systems.

While the model shown in Figure 1 is a relatively simple one, there is a great deal of information that can be packed into each of the boxes that constitute the model. Homeostasis can also be described as a hierarchically arranged set of statements, a conceptual framework, that contains whatever breath and depth of information is appropriate for a particular set of students in a course. We have developed and described such an “unpacking” of the core concept of homeostasis. The model and the conceptual framework provide students with different tools for thinking about homeostasis.