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What is homeostasis?

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Emeritus Professor Kelvin Rodolfo of the University of Illinois at Chicago's Department of Earth and Environmental Sciences provides this answer:

Image: *AMERICAN PSYSIOLOGICAL SOCIETY*
WALTER CANNON devised the term homeostasis in 1930 while referring to how the body maintains its temperature, among other key variables.

Homeostasis, from the Greek words for "same" and "steady," refers to any process that living things use to actively maintain fairly stable conditions necessary for survival. The term was coined in 1930 by the physician Walter Cannon. His book, *The Wisdom of the Body*, describes how the human body maintains steady levels of temperature and other vital conditions such as the water, salt, sugar, protein, fat, calcium and oxygen contents of the blood. Similar processes dynamically maintain steady-state conditions in the Earth's environment. Homeostasis has found useful applications in the social sciences. It refers to how a person under conflicting stresses and motivations can maintain a stable psychological condition. A society homeostatically maintains its stability despite competing political, economic and cultural factors. A good example is the law of supply and demand, whereby the interaction of supply and demand keeps market prices reasonably stable.

Homeostatic ideas are shared by the science of cybernetics (from the Greek for "steersman"), defined in 1948 by the mathematician Norbert Wiener as "the entire field of control and communication theory, whether in the machine or in the animal." Cybernetic systems can "remember" disturbances and thus are used in computer science to store and transmit information. Negative feedback is a central homeostatic and cybernetic concept, referring to how an organism or system automatically opposes any change imposed upon it.

For example, the human body uses a number of processes to control its temperature, keeping it close to an average value or norm of 98.6 degrees Fahrenheit. One of the most obvious physical responses to overheating is sweating, which cools the body by making more moisture on the skin available for evaporation. On the other hand, the body reduces heat-loss in cold surroundings by sweating less and reducing blood circulation to the skin. Thus, any change that either raises or lowers the normal temperature automatically triggers a counteracting, opposite or negative feedback . Here, negative merely means opposite, not bad; in fact, it operates for our well being in this example. Positive feedback is a response to change from the normal condition that increases the departure even more.

For example, if a person's temperature is raised to about 107 degrees Fahrenheit, the negative feedback systems stop operating. A person with a high fever has hot, dry skin if they do sweat to help cool it. Not only have the negative feedback systems shut down in such a case; the increased temperature speeds up the body chemistry, which causes the temperature to rise even more, which in turn speeds up the body chemistry even more, and so forth. This vicious cycle of positive feedback, a "runaway" process, can only end in death if not stopped.

It is important to emphasize that homeostatic reactions are inevitable and automatic if the system is functioning properly, and that a steady state or homeostasis may be maintained by many systems operating together. For example, flushing is another of the body's automatic responses to heating: the skin reddens because its small blood vessels automatically expand to bring more heated blood close to the surface where it can cool. Shivering is another response to chilling: the involuntary movements burn body tissue to produce more body heat.

Negative feedback arises out of balances between forces and factors that mutually influence each other. To illustrate several of its important characteristics, we can regard a car and its driver as a unified, complex, homeostatic or "goal-seeking" system--a cyborg, or "cybernetic organism," in that it seeks to keep the car moving on track. The driver does not steer by holding the wheel in a fixed position but keeps turning the wheel slightly to the left and right, seeking the wheel positions that will bring the naturally meandering car back on track. Disturbance, or departure from equilibrium, is every bit as important as negative feedback: Systems cannot correct themselves if they do not stray.

Oscillation is a common and necessary behavior of many systems. If the car skids, the driver automatically responds by quickly steering in the opposite direction. Such abrupt negative feedback, however, usually over-corrects, causing the car to move toward the other side of the road. A negative feedback, if it is as large as the disturbance that triggered it, may become an impressed change in the direction opposite to that of the original disturbance. The car and driver recovers from the skid by weaving from side to side, swerving a little less each time. In other words, each feedback is less than the last departure from the goal, so the oscillations "damp out." Negative feedback takes time and such a time lag is an essential feature of many natural systems. This may set the system to oscillating above and below the equilibrium level.