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Perspective

# Perspective on Biological Thermodynamics

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## PERSPECTIVE

The quantitative study of energy transductions that occur in or between living organisms, structures, and cells, as well as the nature and function of the chemical processes behind these transductions, is known as biological thermodynamics. Biological thermodynamics may be able to answer the question of whether the advantage of a specific phenotypic characteristic is worth the energy investment. Hans Krebs, a German-British medical doctor and biochemist, published Energy Transformations in Living Matter in 1957, which was the first important work on the thermodynamics of biological reactions. The appendix also included Kenneth Burton's first-ever published thermodynamic tables, which included equilibrium constants and Gibbs free energy of formations for chemical species.

Theoretical models of non-equilibrium thermodynamics have been used to explain how biological creatures might emerge from disorder. Ilya Prigogine devised thermodynamic treatment methods for such systems. He named these systems dissipative systems because they are generated and maintained by dissipative processes that interchange energy between the system and its environment, and they vanish if the system is removed from its environment. They are thought to be in symbiosis with their surroundings. Photosynthesis is the most important energy transformation in biology. Photosynthesis in green plants captures around $2 \times 10^{23}$ joules of energy per year from solar radiation. Photosynthesis in green plants captures around 4% of the total sunlight energy that reaches Earth each year.

The energy transformations in living communities near hydrothermal vents are an exception; they oxidize sulphur and obtain energy through chemosynthesis rather than photosynthesis. The study of chemical thermodynamics in biology and biochemistry is referred to as biological thermodynamics. The first and second laws of thermodynamics, Gibbs free energy, statistical thermodynamics, reaction kinetics, and speculations about the origin of life are among the topics covered. Biological thermodynamics is now concerned with the investigation of internal biochemical dynamics such as ATP hydrolysis, protein stability, DNA binding, enzyme kinetics, and other vital energizing processes.

The change in the Gibbs free energy is a quantitative measure of the amount of energy capable of accomplishing work during a chemical reaction in thermodynamics. Alfred Lotka, a physical biologist, attempted to reconcile the shift in Gibbs free energy with evolutionary theory. For living beings, the sun is their principal source of energy. Some living species, such as plants, require direct sunlight, whilst others, such as people, may obtain energy indirectly from the sun. Some bacteria, however, can flourish in severe conditions such as Antarctica, as evidenced by blue-green algae found beneath thick layers of ice in the lakes. The relationship between the incoming sunlight's energy and its wavelength, or frequency v, is given by E=hc/lamda, where h represents the Planck constant ($6.63 \times 10^{34}$ Js) and c represents the speed of light ($2.998 \times 10^{8}$ m/s). Photosynthesis is the process by which plants capture this energy from the sun and turn it into chemical energy.

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