acid. The sodium salt of glycyl-glycine behaves in a manner intermediate between the sodium salt of glycine and of ε amino caproic acid. Despite its large dipole moment, the apparent molal volume of isoelectric ε amino caproic acid, with its long hydrocarbon chain, changes very little indeed in solutions containing less than 25 per cent. of amino-acid. This type of behavior is also characteristic of most proteins, whose great apparent density in solution diminishes but little even in the concentrations which obtain in biological systems.

EDWIN J. COHN

HARVARD MEDICAL SCHOOL

"EXERGIC" AND "ENDERGIC" REACTIONS[1]

IN the consideration of chemical reactions it is often necessary to distinguish between (a) those processes which occur spontaneously, for example, in a primary cell, that is, which are capable of doing work; and (b) those which require work to be done in order to bring them about, for example, the electrolytic decomposition of water into hydrogen and oxygen. Thermodynamically, these types of reaction are distinguished as resulting in (a) a decrease in free energy and (b) an increase in free energy.

It is proposed to designate these two types of reaction respectively as (a) "exergic," that is, capable of giving out work; and (b) "endergic," that is, taking in work. They are derived from the Greek root "ergon," work.

At first it might appear that the need for such terms is met by the customary expressions "exothermic" and "endothermic." It has long been known, however, that these terms are inadequate to describe chemical reactions, and hence the concept of free energies was introduced. As above noted, the new terms apply to the free energy and not to the total energy of the process. The majority of reactions that are exothermic are also exergic, and most of those that are endothermic are endergic, but the relation is not universal.

Thus, Lewis and Randall[2] cite a cell in which the reaction

$$Ag(s) + HgCl(s) = AgCl(s) + Hg(l)$$

yields at 298° K a potential of 0.0455 V (that is, according to the above definition the process is exergic), although the chemical reaction is endothermic, with a total heat change, $\triangle H_{298}$, equal to +1280 cal. In order for the cell reaction to occur spontaneously, heat must be taken from the surroundings.

Similarly, it follows that the reverse reaction

$$Hg(l) + AgCl(s) = Ag(s) + HgCl(s)$$

is exothermic, that is, $\triangle H_{298} = -1280$ cal.; but in order for this process to occur in a cell, work equivalent to 0.0455 V must be done upon it, that is, the process is endergic.

The need for such terms was evidently felt by H. J. Creighton,[3] who states that chemical changes "are called 'exo-electrical' when they develop electrical energy and 'endo-electrical' when they absorb electrical energy." His terms have much the same meaning as those now proposed, but are somewhat less general in their application.

No new concepts are involved in the proposed terms. Justification for their use must be found in their conciseness or pedagogic convenience. The proposed definitions are as follows:

"Exergic reactions are those which occur with a decrease in free energy."

"Endergic reactions are those which occur with an increase in free energy."

W. BLUM

U. S. BUREAU OF STANDARDS

[1] Publication approved by the director of the U. S. Bureau of Standards.

[2] "Thermodynamics," p. 174. McGraw Hill Book Co., New York, 1923.

[3] "Principles and Applications of Electrochemistry," Vol. 1, 2nd ed., p. 8. John Wiley and Sons, New York, 1928.

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