to C'3a, C'3c, and C'3b described by Nelson *et al.* An additional factor, C'3d, has also been described. This terminology, therefore, is complicated because it reflects both the behavior of these factors on DEAE-cellulose chromatography and the order in which they were discovered. Thus, the symbols bear no relationship to the sequence of action of the various factors. The committee was charged with the task of resolving these nomenclature problems on the basis of experimental evidence. It was agreed that the present symbols should be replaced by C'3, C'5, C'6, and C'7 when the members of the committee reach agreement concerning the identity and sequence of action of the several C'3 factors now recognized.

The meeting was sponsored by the Immunology Section, Diagnostic Research Branch, of the National Cancer Institute. It was attended by 84 persons. This report was prepared after consultation with the participants.


HERBERT J. RAPP
TIBOR BORSOS

*National Institutes of Health,*
*National Cancer Institute,*
*Diagnostic Research Branch,*
*Bethesda 14, Maryland*


**Note**

1. Complement (C') is a group of naturally occurring macromolecular serum factors which interact with antigen-antibody complexes. If the antigen (S) on the surface of an erythrocyte (E) is in combination with specific antibody (A), the complex (SA), or in cellular terms, EA, can interact with C' and as a result the cell is destroyed. The C' components act in the sequence C'1, C'4, C'2, C'3. The third component (C'3) is not a single factor. EAC'1 is a complex produced by interacting EA and C'1, similarly complexes reacting further in the sequence are designated EAC'1,4, EAC'1,4,2, and so forth. A cell which has reacted with A and all the components of C' is designated E*. Cells in the state E* release their hemoglobin at a rate dependent on temperature. In molecular terms, the symbol E is replaced by the symbol S. $R_1$, $R_2$, $R_3$, and $R_4$ refer to sera so treated that C'1, C'2, C'3, and C'4, respectively, are lacking. Terms beginning with the symbol $\beta$ refer to components identified by immunoelectrophoretic analysis. See also E. A. Kabat and M. M. Mayer, *Experimental Immunochemistry* (Thomas, Springfield, Ill., ed. 2, 1961).

## Thirst: Regulation of Body Water

Scientists representing many disciplines focused their attention on a common problem, water intake in the regulation of body fluids, at a conference held at Florida State University, Tallahassee, 1–3 May.

In the opening address E. R. Adolph (Rochester) discussed terminology, quantitative relations between water deficit and drinking, the history of these concepts, and the evolution of modern experimental methods. As there is no "unique stimulus" for drinking, Adolph emphasized the need to specify and determine the relationships between the multiple factors related to drinking and the regulation of volume and dilution in the animal body. The emphasis on the remarkable differences in water intake between species and among individuals was amplified by Hudson's (Rice) comprehensive treatment of water regulation in desert mammals and Cade's (Syracuse) analysis of water and salt balance in granivorous birds. The multiple-factor concept of the determination of water intake was confirmed by much of the evidence presented.

Minimal water requirements under conditions of heat and work were discussed by Henschel (U.S. Public Health Service, Cincinnati, Ohio). Although difficult to determine because of differences in individuals, conditions of work, and environment, considerable data are available and specific recommendations can be made for a variety of situations. Several physical and chemical methods have been developed to provide an adequate supply of water under unusual environmental conditions, such as shipwreck at sea or confinement for prolonged periods in an enclosed vehicle (Sendroy, U.S.N. Medical Research Institute, Bethesda). Interactions of water, food, and temperature regulation in the monkey during short-term heat and cold stress were described by Hamilton (Veterans Administration Hospital, Coatesville, Pennsylvania).

Holmes (Colorado) demonstrated that thirst is still a serious consideration in clinical medicine where the oral factors are important determinants of fluid intake. Interactions among osmotic pressure, salivary flow, vasopressin, plasma volume, and water intake were emphasized by Towbin (VA Hospital, Little Rock). He also speculated on the role of specific "taste" afferents in the determination of fluid intake. Towbin's discussion of the role of gastrointestinal factors in the absorption of water and satiety was followed by Jacobs (Illinois, Urbana) who reported on the experimental separation of oral and gastric factors in water-food ingestion in the rat. An interesting analysis of psychogenic polydipsia emphasized that without proper tests this condition can be confused with diabetes insipidus (Falk, Michigan). Effects of propylthiouracil, thiouracil, and methimazole

indicate that thyroid hormone plays a role in the maintenance of renal tubular sensitivity both to antidiuretic hormone and to aldosterone. Fregly (Florida, Gainesville) suggested that the thyroid may be of greater significance in the maintenance of sodium and water balance than hitherto suspected. According to Novin (University of California at Los Angeles), insulin causes an increase in water intake and seems to be related to a reduction in extracellular volume. A relatively complete analysis of the effects of various drugs, particularly the barbiturates, on drinking was presented by Schmidt (Washington University).

The psychophysics of fluid intake and preference, isohedonic contour maps based on preference tests, and activity surfaces based on tongue contacts with a single fluid were described by Young and Trafton (Illinois, Urbana). Thirst was noted as a determinant of the reinforcing properties of various kinds of solutions (Collier, Rutgers). Adaptation to prolonged water deprivation (Kutscher, Syracuse) and the effects of consummatory behavior (Beck, Wake Forest) were reported. Campbell (Princton) discussed the effects of water and food deprivation on random activity in the rat. An increase in spinal reflex excitability associated with the intracarotid injection of hypertonic solutions was reported by Wayner (Florida, Tallahassee) and preliminary results on the central pathways involved in its mediation were presented by Ross (Syracuse).

The preoptic region plays an important role in the interaction among drinking, eating, and temperature regulatory activities (Andersson and Gale, Stockholm; Sundsten, Washington, Seattle). Effects of hypothalamic lesions on eating and drinking and the difficulty in achieving independent experimental manipulation of the pertinent variables were demonstrated by McCann and Smith (Pennsylvania), and Epstein and Teitelbaum (Pennsylvania). These support a multifactor explanation for water intake and the fact that some hypothalamic tissue is indispensible for normal regulation. The concept of "brain center" again received a number of shattering blows. The size of lesion, spread of electrical and chemical stimulation, and activity through associated neural structures and pathways were emphasized. Robinson (National Institute of Mental Health) discussed the difficulties, limitations, and statistical nature of the

localization within specific structures in the monkey brain which affect drinking, eating, food ejection, and vomiting. He suggested a new set of organizational principles to explain these effects. The complexity of the anatomical correlates in drinking and thirst-motivated behavior was clearly illustrated by Morgane's (Brain Research Unit, Mexico City) description of the limbic-hypothalamic-midbrain structures involved in their mediation. While the subcommissural organ is involved in water-electrolyte balance (Gilbert, U.S. Air Force Hospital, Travis, Calif.), some data contradict this theory (Crow, Western Washington State).

Recent research on the neurochemical specificity of central mechanisms involved in drinking and eating was summarized by Grossman (Iowa) and Fisher (Pittsburgh). The effects of chemical stimulation have proved to be more complex than originally envisaged and indicate that the interaction between thirst and hunger may be determined centrally as well as peripherally. Repeated intracranial infusion (cerebrospinal fluid) of minute amounts of alcohol in the rat produced a permanent preference for alcohol solutions which animals had previously refused to ingest (Myers, Colgate). Stevenson (Western Ontario) summarized and reassessed the relative functions of the various hypothalamic mechanisms in drinking and the regulation of body water.

In spite of the research effort and the voluminous literature which has accumulated on drinking and the regulation of body fluids, no unifying concept or theory has evolved to explain drinking under all conditions. The results of this conference indicate that multiple factors such as osmotic pressure, solute, taste, timing, and heterologous stimuli and alimentary, nervous, and endocrine factors are involved. To borrow a few more terms from Adolph, we hope that in bringing the "sluicers" and "slicers" together we have provided the opportunity for some cross-fertilization and the germination of many ideas.

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MATTHEW J. WAYNER, JR.
*Florida State University, Tallahassee*
EUGENE M. SPORN
*Life Sciences Division,*
*U.S. Army Research Office*