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Aristotle, Newton, Einstein: PROFESSOR E. T. WHITTAKER 267

The Longevity of the Eminent: DR. HARVEY C. LEHMAN 270

Obituary:

Rennie Wilbur Doane: JOHN M. MILLER. *Leslie Leland Locke:* PROFESSOR LOUIS C. KARPINSKI. *Recent Deaths* 273

Scientific Events:

The North Pacific Planning Project; Escuela Agrícola Panamericana; The Chicago Museum of Natural History; The National Metal Congress; The Louis Livingston Seaman Fund; Need for Water-Insoluble Forms of Water-Soluble Vitamins 275

Scientific Notes and News 278

Discussion:

Twenty-Five-Year Effort at Saving Nature for Scientific Purposes: DR. VICTOR E. SHELFORD. *On Methods of "Starring" American Men of Science:* DR. C. A. BROWNE. *Clavacin and the Press:* PROFESSOR H. W. ANDERSON 280

Scientific Books:

Blood Groups and Transfusion: PROFESSOR WILLIAM C. BOYD. *Chemistry:* DR. R. E. POWELL 283

Special Articles:

The Serological Activity of Denatured Antibodies: J. O. ERICKSON and DR. HANS NEURATH. *Protective Effect of Separate Inoculation of Spotted Fever Virus and Immune Serum by Intradermal Route:* PROFESSOR L. ANIGSTEIN, MADERO N. BADER and GERALD YOUNG 284

Scientific Apparatus and Laboratory Methods:

Observations on the Biological Value of a Mixture of Essential Amino Acids: DR. ANTHONY A. ALBANESE and VIRGINIA IRBY 286

Science News 10

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ARISTOTLE, NEWTON, EINSTEIN. II

By Professor E. T. WHITTAKER, F.R.S.

UNIVERSITY OF EDINBURGH

THE problem that now confronted physicists was this: How can local properties, such as a gravitational field, exist in space when the existence of an ether is not a permissible supposition? The answer was furnished, in 1915, by the "General Theory of Relativity" of Einstein. He discarded Gassendi's assumption that space was a uniform characterless vacuum, and postulated that it had a property of curvature, varying from point to point: and that just as (to make use of a rough analogy) a paramagnetic body when placed in a magnetic field tends to move from the weaker to the stronger places in the field, so a massive body in space might be pictured as moving from places of weak to places of strong curvature. The curvature, in fact, performs in general relativity the same kind of function as the density and rigidity of the ether did in classical physics; but, unlike the ether-properties,

it does not come into conflict with the principle of relativity. In Einstein's conception, space is no longer the stage on which the drama of physics is performed: it is itself one of the performers; for gravitation, which is a physical property, is entirely controlled by curvature, which is a geometrical property of space.

In Einstein's theory of gravitation the Newtonian concept of force is completely done away with; a free particle moves in a path determined solely by the curvature-properties of space; it is, as the Aristotelians would say, in potency with regard to space, and things in a state of potency continually seek to become actualized. The changes of position of the particle, in their turn, bring about changes in the curvature of space, so that the particle and space together may be regarded as a single system whose evolution is determined by the law that the total curvature of space-

these animals likewise was far from thriving. When a change was made to the Amigen ("A") diet or the fortified acid hydrolysate ("CTH") diet, gain in weight was promptly restored. The superior growth of animals on the Amigen diet as compared with the "CTH" diet may well be due to the pancreatic proteins present in Amigen, proteins which have recently been shown to have a high nutritive value.¹⁰ The growth curves of animals on Amigen are comparable to those on casein with the exception of a slight lag when the animal is first put on Amigen.

Nitrogen balance studies were made on six additional animals which were fed the "EAA" diet. These studies were repeated after the diet had been changed to "CTH" diet. The data are shown in Table 1. It

TABLE 1
NITROGEN BALANCE OF RATS MAINTAINED ON THE AMINO ACID MIXTURE AND REINFORCED ACID HYDROLYZED CASEIN DIETS

Rat number and sex	Initial body weight	Amino acid mixture diet 4 × 3 day periods				CTH diet 4 × 3 day periods			
		Average daily food intake	Average N-balance per day	Weight change		Average daily food intake	Average N-balance per day	Weight change	
	gms	gms	mgms	gms		gms	mgms	gms	
EAA-10 ♂	60	4.2	+22.5	-20		4.0	+31.1	+5	
EAA-11 ♂	60	4.4	+29.7	-17		4.0	+30.2	+4	
EAA-12 ♂	60	4.1	+31.8	-16		4.0	+42.0	+9	
EAA-13 ♂	52	3.9	+29.2	-15		4.0	+46.0	+8	
EAA-14 ♂	61	3.45	+12.8	-21		3.67	+36.0	+7	
EAA-15 ♂	44	3.90	+19.8	-10		3.92	+40.8	+7	

will be noted that although the diet on the "CTH" period was restricted to that taken on the "EAA" period, the animals gained weight during the "CTH" period in contrast to the loss of weight which occurred on the essential amino-acid diet. Despite the loss of weight on the "EAA" diet, the animals retained nitrogen, although the retention was noticeably less than that on the complete amino-acid diet. These experiments emphasize the fact that in the growing animals nitrogen retention can not be taken as a criterion of adequate nutrition.

Several possible explanations for the nutritive failure of the animals on the "EAA" diet suggest themselves. It is conceivable that the particular mixture employed contained too little of some one amino acid. In order to evaluate this possibility, a diet was prepared which contained essential amino acids in double the quantity used before (comprising 29.4 instead of 14.7 per cent. of the diet). Control experiments were carried out in which the nitrogenous moiety was supplied as "CTH" hydrolysate at twice

the previous level. The food intake of the control animals was restricted to that of the "doubled EAA" group. The control animals on "double CTH" all survived, although their weight curves were flatter than those of the animals on 14.7 per cent. "CTH." On the other hand, the results on the high intake of essential amino acids were most unsatisfactory. Of six rats (54-60 gms) submitted to this diet, 3 ate well and died within 5 days, the other 3 ate the diet poorly and survived until sacrificed 3 weeks later. The weight loss in these animals was much more striking than in the 14.7 per cent. "EAA" animals.

It seems possible that the toxic effects of the high "EAA" diet as compared to the high "CTH" diet are brought about by the unnatural isomers of certain amino acids which can not be utilized by the animal. Bauer and Berg⁵ attribute their unfavorable results with mice on a ten amino-acid diet to the "cost" of the additional synthetic work the organism is called on to perform—in energy and in building materials, undoubtedly factors of importance, but it is difficult to attribute the effects observed in our animals to other than a toxic cause. The possibility that one or more unutilizable optical forms of amino acids may exert a toxic influence is one that demands verification by direct experiment, and until it has been definitely excluded it would seem wise to employ only the natural forms in human therapy.

SUMMARY

(1) A mixture of "essential" amino acids, fed to rats, was found to be inferior from a nutritional point of view to enzymatic or acid casein hydrolysates or casein fed at comparable levels.

(2) Evidence is presented which suggests that the nutritive inadequacy of the essential amino-acid diet may be due in part to toxic effects of unnatural forms of certain amino acids that can not be utilized.

ANTHONY A. ALBANESE
VIRGINIA IRBY

BOOKS RECEIVED

- Biographical Memoirs*. Vol. XXII. National Academy of Sciences of the United States of America.
ANDREWS, ROY CHAPMAN. *Under a Lucky Star*. Pp. 300. The Viking Press. \$3.00.
BARBOUR, THOMAS. *Naturalist at Large*. Illustrated. Pp. 314. Little Brown and Company. \$3.50.
SHARP, LESTER W. *Fundamentals of Cytology*. Illustrated. Pp. x+270. McGraw-Hill Book Company. \$3.00.
SMALL, SIDNEY AYLMEY and CHARLES RAMSEY CLARKE. *Simplified Physics*. Illustrated. Pp. ix+428. E. P. Dutton and Co. \$3.00.
STRONG, EVERETT M. *Electrical Engineering Basic Analysis*. Illustrated. Pp. xii+391. John Wiley and Sons. \$4.00.
TURRENTINE, J. W. *Potash in North America*. Illustrated. Pp. 186. Reinhold Publishing Corporation. \$3.50.

¹⁰ A. White and M. A. Sayers, *Proc. Soc. Exp. Biol. and Med.*, 51: 270, 1942.



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