State Agricultural College, who met the geologists and students, sixty in all, at 8:00 A.M., Friday, May 13, at Brigham City and conducted them through Cache Valley. Many interesting features were visited and studied. Twenty-four papers were presented in the Biological Section, five in the Social Science Section and six in the Arts and Letters Section.

A vote of thanks and appreciation was extended to the local committee—Drs. W. W. Henderson, *Chairman,* Bert L. Richards and O. W. Israelson—and the officials of the college for the splendid manner in which they handled the academy meetings.

It was decided to hold the autumn meeting of the academy at Brigham Young University.

VASCO M. TANNER,
Permanent Secretary-Treasurer

SPECIAL ARTICLES

ON THE PROPERTIES OF RECTILINEAR FIGURES OF n DIMENSIONS

SOME years ago the writer derived some curious relations between functions of the expression 2^n which appear to be of sufficient interest to publish.

TABLE I

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
n =	0	1	2	3	4	5	
2^n	1	2	4	8	16	32	Points
$\frac{n}{1}.2^{n-1}$		1	4	12	32	80	Lines
$\frac{n(n-1)}{2!}.2^{n-2}$			1	6	24	80	Areas
$\frac{n(n-1)(n-2)}{3!}.2^{n-3}$				1	8	40	Volumes
$\frac{n(n-1)(n-2)(n-3)}{4!}.2^{n-4}$					1	10	*
$\frac{n(n-1)(n-2)(n-3)(n-4)}{5!}.2^{n-5}$						1	*
Figures of :—	0 dimensions (Points)	1 dimension (Lines)	2 dimensions (Squares)	" (Cubes)	" (Tesseracts)	"	
				3	4	5	

From the expression 2^n, if we derive the expressions:

$$\frac{n}{1}.2^{n-1};\ \frac{n(n-1)}{2!}.2^{n-2};\ \frac{n(n-1)(n-2)}{3!}.2^{n-3};$$

$$\frac{n(n-1)(n-2)(n-3)}{4!}.2^{n-4};$$

etc., with, as the m^{th} term:

$$\frac{n(n-1)(n-2)(n-3)\ \ldots\ (n-m+2)}{(m-1)!}.2^{n-m+1}$$

and in them substitute for n the values 0, 1, 2, 3, 4, . . ., Table I can be prepared.

In column (2) the properties of a point are described, and in columns (3), (4) and (5) the properties of lines, squares and cubes respectively. In column (6) the tesseract, which possesses 8 cubes, 24 squares, 32 lines and 16 points, is indicated. It seems reasonable to conclude, therefore, that column (7) would indicate the properties of the corresponding fifth-dimensional figure, whilst the extension of these expressions would remain true for rectilinear figures of n-dimensions.

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PHOSPHORYLATION OF GLYCOGEN IN VITRO

PHOSPHORYLATED carbohydrates are of particular interest in view of the role of phosphorylated intermediates in the breakdown of glycogen by muscle enzymes. The synthesis of phosphorylated glycogen was therefore undertaken. The preparation of a new compound, namely, the calcium salt of the phosphoric acid ester of glycogen, is described.

The method for phosphorylating glycogen adopted was similar to that employed by Kerb[1] for phosphrylation of starch. Thirty grams of glycogen (free of phosphorus) were dissolved in 750 cc of hot water and, after cooling, 120 gm of calcium carbonate were added. The mixture was then cooled to about 3° and 25 gm of phosphorus oxychloride in 75 cc of chloroform

[1] J. Kerb, *Biochem. Z.*, 100: 3, 1919.

added dropwise while the mixture was stirred; stirring was continued for 4 hours. The mixture was next allowed to stand for 6 hours, then filtered through a Büchner funnel and the precipitate washed with 700 cc of water. The filtrate was concentrated at 40° C. *in vacuo* to a volume of approximately 200 cc and its glycogen precipitated by the addition of an equal volume of 95 per cent. alcohol. The precipitate was permitted to settle, then filtered and washed with alcohol. Further purification was effected by twice redissolving in water and reprecipitating from alcohol. Finally it was dried *in vacuo* at 40° to constant weight. This phosphorylated glycogen contained 0.43 per cent. phosphorus and 0.57 per cent. calcium.

The phosphorylation was repeated 7 times by the above method, with a consequent increase in its phosphorus content each time. After the seventh operation, the phosphorylated glycogen contained 1.73 per cent. phosphorus and 2.66 per cent. calcium. Its specific rotation $(\alpha)_D$, after being dried *in vacuo* at 40° to constant weight, was +174°.

The phosphorylated glycogen was soluble in water and the presence of ionic calcium was demonstrated by its precipitation upon the addition of ammonium oxalate. No test for phosphate was obtained with ammonium molybdate, even after acidifying and boiling with dilute nitric acid for a few minutes. Phosphoric acid was split off, however, by treating the phosphorylated glycogen with a few cc of hydrogen peroxide and several drops of nitric acid containing a trace of ferric nitrate, after the manner of Neuberg and Mandel.[2]

The phosphorylated derivatives obtained by enzymatic hydrolysis of the phosphorylated glycogen will be described elsewhere.

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A PRELIMINARY REPORT ON THE SPECIFICITY OF KERATINS[1]

ALTHOUGH species specificity is a general attribute of proteins, serological species differences of keratins have been generally accepted as either poorly defined or not demonstrable.

The experiments of Krusius,[2] in which he employed antiformin for the preparation of keratin, led to hydrolysis and alterations in the protein-molecule which may account for the lack of specificity of keratins from different species. Krusius himself realized this possibility.

Recently, Goddard and Michaelis[3] observed that keratin owes its peculiar resistance against dissolving agents to the di-sulfide bonds in their original positions, which are mainly responsible for the pattern of the structure of keratin and also its physical properties. These observers were able to split these di-sulfide groups by reducing agents in such a manner as to leave intact the chemical composition and avoiding hydrolytic splitting. The reduced protein obtained was called "kerateine" and it behaved more like an ordinary protein than native keratin, both with respect to solubility and behavior toward proteolytic enzymes.

The immunological investigations to be described here were primarily directed toward the study of the antigenic power and specificity of oxidized and reduced keratins prepared by the method of Goddard and Michaelis.

Keratins were prepared from human hair, wool and chicken feathers. Elementary chemical analysis revealed that the compounds are closely related. The total nitrogen, sulfur, cystine and isoelectric points are essentially identical in all the preparations employed.

In brief, the results of these studies disclosed that species specificity is an individual characteristic of the keratins employed and that the specificity observed is dependent on the redox state of the sulfhydryl groups in the protein molecule.

In cross-precipitation reactions overlapping was encountered, and especially in low dilutions of the antigens; but in the very dilute antigens, *i.e.*, ($\pm$ 1:25,000), the antiserums gave specific precipitates in the presence of their homologous antigens.

Of greater significance is the finding that species specificity was obtained only when the reduced keratin (kerateine) was allowed to react with the antiserum prepared by the injection of the homologous reduced keratin; while marked overlapping occurred when oxidized keratin (metakeratin) and the parent protein (75 per cent. oxidized) were employed as antigens.

The same phenomenon was observed when oxidized keratin was allowed to react with its homologous antiserum. This indicates that not only are the keratins species specific, but that immunological differences are detectable in a single keratin preparation depending on the state of oxidation or reduction of the protein employed.

It would seem, as data upon the basic amino acids content of proteins accumulate, that recognition must be given to the view that there exists a central basic nucleus characteristic for any one biological type of

[2] C. Neuberg and J. A. Mandel, *Biochem. Z.*, 71: 196, 1915.

[1] From the Institute of Pathology, Western Reserve University and the University Hospitals, Cleveland, Ohio. Aided by a grant-in-aid, Division Medical Sciences, National Research Council.

[2] Fr. F. Krusius, *Arch. f. Augenheilkunde*, Supplement, 67: 47, 1910.

[3] D. R. Goddard and L. Michaelis, *Jour. Biol. Chem.*, 106: 605, 1934.