In the study of the section on hyperfine structure, the reader may be helped by the following remarks. For single-electron spectra all the formulas given can be summarized by $\Delta w = \frac{a}{2}[f(f+1) - i(i+1) - j(j+1)]$; $a = \frac{2g\mu_0^2 l(l+1)}{1840 j (j+1)} \cdot \overline{\left(\frac{1}{r^3}\right)}$ where for $l = 0$ one should use the limiting value $l(l+1)\overline{r^{-3}} = 2\pi\psi^2(0)$ and the nuclear g factor is expressed in terms of the theoretical magnetic moment of the proton. The energy expression for the lowest ^3S term of Li which is given by

$$1.06\frac{8\pi}{3}\mu_0 M\psi^2(0)\left(-\frac{5}{3}, -\frac{2}{3}, 1\right)$$

as Equ. (1) on p. 425 takes into account the influence both of the 1s and the 2s electrons. The correction for the 2s electron is represented by the factor 1.06 and has been computed by two independent methods, one of which consists in a variational calculation of the cartesian coordinate wave function. The present status of calculations on hyperfine structure in intermediate coupling is that deviations from theory are of the correct order of magnitude to be explicable as due to the same cause as the deviations of properties of gross structure from theory. This conclusion has been arrived at by comparing expressions for wave functions derived from different properties of the gross structure such as intervals and the Landé g factors for the Zeeman effect. This study therefore indicates that the interaction between configurations is related to the deviations of hyperfine structure from the theoretical relations which correspond to simple configuration assignments.

The book contains many neat and useful points which add to its value as a general reference volume. Thus on page 127 one finds a neat explicit representation of functions for Dirac's equation in a central field leading to the two radial equations which are so useful in applications. Here also one finds Darwin's reduction of the Dirac equation to the Pauli spin form, but one should be cautioned against applying this form to hyperfine structure. Similarly, one finds reference to the use of Dirac's vector model made by Van Vleck and a detailed summary of self-consistent field calculations.

G. BREIT

SPECIAL ARTICLES

GROWTH IN HEIGHT AND WEIGHT IN COLLEGE AND UNIVERSITY WOMEN

MEAN height and weight measurements of college and university women, when obtained from independent samples of the population at successive ages, have revealed no consistent changes associated with advancing age.[1] Consecutive annual measurements made upon the same individuals do not confirm this result.[2] They indicate that there is a small but significant increase in these measures of physique throughout the four college years. These contradictory findings prompted the present investigation in which the same data are subjected to the two different types of analysis. The data were made available to us by the Department of Physical Education for Women at Stanford University.

Height and weight measurements were assembled from 1,290 individuals. Of these 1,134 were remeasured after one year, and 446 after two years. In assigning the measurements to specific ages, a certain degree of arbitrariness could not be avoided because the time at which measurements were made varied widely with respect to the subjects' birthdays. We assigned to a given age-group any measurement that was made within an interval of six months preceding and six months following the birth date. The majority of remeasurements followed first measurements with an interval closely approximating one or two years. The means of the intervals are 11.5 and 23 months, respectively.

When these data are analyzed by computing the mean measurements for independent samples at the successive ages, we obtain the results presented in Table 1. If two or more annual measures were avail-

[1] Fritz Bach, *Zeits. f. Konstit. lehre*, 16: 28–62, 1931; H. S. Diehl, *Human Biology*, 5: 600–628, 1933; H. N. Gould, *Research Quart. of the Amer. Physical Ed. Assn.*, 1: 1–18, 1930; C. M. Jackson, *Am. Jour. Physical Anthrop.*, 12: 363–413, 1928.

[2] B. F. Baldwin, *Univ. Iowa Studies: Stud. Child Welfare*, 1: pp. 411, 1921; H. N. Gould, *ibid.*

TABLE 1

HEIGHT AND WEIGHT DATA FOR WOMEN STUDENTS AT STANFORD UNIVERSITY. (INDEPENDENT SAMPLES AT EACH AGE; NO REMEASUREMENTS)

Age	N	Height (inches)			Weight (pounds)		
		Mean	S.D. mean	S.D. dist.	Mean	S.D. mean	S.D. dist.
17	331	64.75	.09	1.69	124.85	.85	15.72
18	553	64.71	.09	2.19	123.05	.65	15.31
19	263	64.72	.14	2.26	123.24	.98	15.84
20	94	64.63	.23	2.28	120.90	1.41	13.70
21	49	64.54	.34	2.37	125.56	2.80	19.58

TABLE 2

MEAN INCREMENTS IN HEIGHT, BASED UPON CONSECUTIVE MEASUREMENTS OF THE SAME INDIVIDUALS

Measured at	N	Height at younger age		Height at older age		r.*	Increment	Incre.
		Mean	S.D.	Mean	S.D.			S.D. incre.
17 and 18 ..	224	64.603	1.418	64.763	2.175	.979	.160	2.8
18 " 19 ..	435	64.698	2.125	64.853	2.203	.968	.155	5.9
19 " 20 ..	339	64.807	2.288	64.898	2.311	.982	.091	3.8
20 " 21 ..	136	64.426	2.338	64.441	2.294	.984	.015	0.4
17 " 19 ..	132	64.462	1.612	64.750	2.184	.965	.288	4.4
18 " 20 ..	214	64.621	2.135	64.790	2.191	.953	.169	3.7
19 " 21 ..	100	64.620	2.261	64.740	2.410	.972	.120	2.1

* Product-moment correlations between the measures at the younger and at the older ages.

able for a given subject, we used only the first of these in the present calculations. It will be noted that there is no consistent change in mean height or weight from age to age and that none of the differences are statistically significant. The mean weight at 20 years is somewhat lower than would have been expected from the trend of the preceding and following means. We have no way of determining the cause of this fluctuation. It is clear that this analysis gives no indication of growth in this group of university women between the ages of 17 and 21.

When these data are analyzed by computing the mean heights and weights of the same subjects on successive years we obtain the results presented in Tables 2 and 3. Table 2 gives the statistical constants for the height distributions at the ages of first measurement and at the ages of remeasurement. It may be seen that there is a small but significant mean annual and biennial increment in height for consecutive ages from 17 to 20 years. An estimate of the total increment from 17 to 21 years is .4 inch. As shown by the data of Table 3, there are also significant annual increments in weight between the seventeenth and nineteenth years, and significant biennial increments between the ages of 17 and 20 years. For the four-year period, the estimated mean increment is 5.75 pounds. This analysis gives unmistakable evidence of growth in this group of university women between the ages of 17 and 21 years.

The results of the two methods of studying height and weight data confirm the results of previous investigations which have come to our attention. When independent samples of the female college population at successive ages are used, no evidence of growth is found; when the same subjects are measured at successive ages, clear evidence of growth appears. It is apparent that there is no discrepancy as to fact, the discrepancy arises from the method used and the conclusions drawn therefrom. There can be no doubt that the method involving remeasurements of the same individuals offers the best control and that the conclusion that growth continues during the college years is justified.

The reason that studies based upon independent samples at different ages fail to reveal growth probably is the differential selection with respect to the physique of college women of different ages. The younger college women represent a group that is precocious physically as well as mentally. Although the correlation between mental and physical precocity is known to be low,[3] the younger college entrants may also be selected for economic advantage and good health, both of which are positively correlated with superior physique.

In presenting this note[4] the authors hope not only to point out the methodological basis of an apparent discrepancy in the results of different investigators, but also to stimulate others to search in the archives

[3] D. G. Paterson, "Physique and Intellect," New York: Century. Pp. xxvii + 304. 1930.

[4] These data were assembled in connection with a more comprehensive study on the relationship between physique and menarcheal age in university women, soon to appear in the journal *Human Biology*.

TABLE 3

MEAN INCREMENTS IN HEIGHT, BASED UPON CONSECUTIVE MEASUREMENTS OF THE SAME INDIVIDUALS

Measured at	N	Weight at younger age		Weight at older age		r.*	Increment	Incre.
		Mean	S.D.	Mean	S.D.			S.D. incre.
17 and 18 ..	224	124.175	15.671	126.605	15.823	.919	2.430	5.8
18 " 19 ..	436	124.060	15.892	126.065	16.031	.923	2.005	6.6
19 " 20 ..	339	124.300	15.798	124.800	15.802	.929	0.500	1.5
20 " 21 ..	135	121.020	13.001	121.835	13.979	.915	0.815	1.7
17 " 19 ..	132	123.370	16.173	126.170	16.868	.893	2.800	4.2
18 " 20 ..	210	121.855	15.359	124.355	15.522	.910	2.500	5.5
19 " 21 ..	100	121.700	13.282	122.800	14.283	.913	1.100	1.9

* Product-moment correlations between the measures at the younger and at the older ages.

of physical education departments for publishable consecutive measurements of physique, and to encourage departments which do not repeat the measurements to do so in order that a sizable mass of consecutive measurements may be assembled. Probably the best sources of data by means of which the terminal phases of physical development may be studied at the present time are the college and university populations.

ROGER G. BARKER
CALVIN P. STONE

DEPARTMENT OF PSYCHOLOGY
STANFORD UNIVERSITY

KETENE ($CH_2=CO$): A NEW REAGENT FOR THE DETOXIFICATION OF VACCINE[1]

KETENE reacts with water, alcohols, primary and secondary amines and acids to form acetylated compounds, according to the investigations of Staudinger.[2] The rate of reaction of ketene for each of the above groups is different—primary amines react most rapidly. In general, the reactions of ketene are addition reactions and may be illustrated as follows:

$$CH_2=CO+H\text{–}NH\text{–}R \longrightarrow CH_3CONH\text{–}R.$$

Bergmann and Stern[3] have shown that ketene reacts with amino-acids to form acetylated amino-acids. Recently Herriott and Northrop[4] used ketene for acetylating the amino groups of pepsin. In our work *B. dysenterae* Shiga were treated with ketene.

Ketene was produced by the thermal decomposition of acetone vapors in a generator similar in design to Herriott's.[5] The gas was passed through a long water condenser and then through a spiral coil, which was cooled to 0° C. to condense any acetone vapors and polymers of ketene. After leaving the ice trap the ketene was passed through a 4 mm tube into a collodion dialyzing sack containing a twenty-hour culture of *B. dysenterae* Shiga suspended in 10 cc of saline solution and 190 cc of 2 M sodium acetate solution. The sack was immersed in a vessel containing 2 M sodium acetate solution in order to keep the pH nearly constant (a procedure adopted by Herriott and Northrop for maintaining a constant pH). Ketene was run into the bacterial suspension at the rate of one bubble per second for one half hour. A mechanical stirring device kept the suspension agitated.

One half hour exposure of the bacterial suspension to ketene was sufficient to kill the organisms. Such a treated suspension was washed with sterile distilled water once and with sterile saline solution three times before the desired density of the suspension was made. A control vaccine was prepared by heating a suspension of the bacilli at a temperature of 60° C. for 45 minutes.

Rabbits were inoculated intravenously at seven-day intervals with ketene-treated vaccine. The lethal dose of either heat-killed suspension or living bacilli suspension was given intravenously from one week to eleven days after the last injection of vaccine. All vaccines were of a density of 300 according to the Fuller's scale.

The results of intravenous inoculation into rabbits all weighing over 2,000 grams are shown in Table I.

TABLE I

Rabbit	Number of inoculations	Total cc of vaccine given	Days between first inoculation and lethal dose	Lethal dose cc	Results
		Immunized with ketene treated vaccine			
1	3	2	33	0.5 H	No toxic effects
2	3	2	33	0.5 H	" " "
3	3	2	27	0.5 H	" " "
4	3	2	27	0.5 H	" " "
5	4	2	28	0.5 H	" " "
6	4	2	28	0.5 H	" " "
7	4	2	28	0.5 H	" " "
8	4	2	28	0.5 L	" " "
9	4	2	28	0.5 L	" " "
10	4	2	28	0.5 L	" " "
		Non-immunized controls			
11	1	0	0	0.4 H	Complete paralysis. Died—36 hrs.
12	1	0	0	0.5 H	Complete paralysis. Died—40 hrs.
13	1	0	0	0.5 H	Complete paralysis. Died—34 hrs.
14	1	0	0	0.5 H	Complete paralysis. Died—36 hrs.
15	1	0	0	0.5 H	Complete paralysis in 60 hrs.*
16	1	0	0	0.5 H	Complete paralysis in 72 hrs.*
17	1	0	0	0.5 H	Paralysis in 52 hrs.*
18	1	0	0	0.5 L	Complete paralysis in 32 hrs.*

L—Living bacilli suspension.
H—Heat-killed vaccine.
*—Animal chloroformed.

Ten rabbits, each previously receiving a series of injections of ketene-treated vaccine over a period of 27 to 33 days, totaling 2 cc, manifested no toxic effects upon receiving the lethal dose of 0.5 cc of either heat-killed or living *B. dysenterae* Shiga. Eight control rabbits which had not received the ketene-treated vaccine showed complete paralysis with usual diarrhea and died within four days after each had been injected with 0.5 cc of either heat-killed or living *B. dysenterae* Shiga.

CONCLUSION

Acetylation of *B. dysenterae* Shiga with ketene for one half hour detoxifies the antigen. Such an antigen can be inoculated in large doses into rabbits without

[1] Preliminary report.
[2] H. Staudinger, "Die Ketene," Stuttgart, F. Enke, 1912.
[3] M. Bergmann and F. Stern, *Ber. Chem. Ges.*, 63: 437, 1930.
[4] R. M. Herriott and J. H. Northrop, *Jour. Gen. Physiol.*, 18: 35, 1934.
[5] R. M. Herriott, *Jour. Gen. Physiol.*, 18: 69, 1934.