was not Pavlov's fault, and he had no part in it. He was a great and simple and completely honest man, and one who was altogether unspoilt, morally and intellectually, either by public adulation or by the reverence of his colleagues.—*A. V. Hill, in the British Medical Journal.*

SPECIAL ARTICLES

DETERMINING THE AVERAGE FIBER LENGTH IN WOOL YARNS

IN studies relating to the standardization of fabricated wools, one of the problems is that of determining the average fiber length in yarns forming the material. Inasmuch as the methods in use are far from satisfactory, a new method based on a simple principle, namely, the number of fiber ends in a given section of a sample, is presented.

Since the number of ends is twice the number of fibers, one obtains the aggregate length of all fibers, assuming them continuous, and divides the result by one half the number of ends. The latter determination is based on an average from a series of counts in random cross-sections under a microscope. Thus knowing the length (s) of any sample, the number (n) of fibers in a cross-section and the average number of ends (e), the formula for average length (l_1) is expressed by a simple equation (1)

$$l_1 = 2\ (sn/e) \quad \text{.....(1)}$$

applicable to any textile thread of yarn composed of ordinary fibers.

There are several peculiarities in yarns, however, which need consideration, one the irregular arrangement of fibers, particularly in woolens, the other the twisting of the yarn in spinning. While fibers composing a worsted are relatively long and straight, those in a woolen yarn are short and irregular in position. This irregularity usually presents some recurved fibers, particularly at the surface, and the number thus added to a cross-section gives results approximating those obtained for worsteds. In connection with the process of spinning, one may consider the fibers as helices with an angle (θ) measuring the pitch. This presents two possibilities.

If the axial fibers are not under a longitudinal tension due to spinning, one may substitute $s/\sin\theta$ for (s) in equation (1) and the average length (l_2) is indicated by equation (2).

$$l_2 = 2\ (s/\sin\theta)\ n/e \quad \text{.....(2)}$$

If, however, the axial fibers are under tension, a different mathematical treatment is needed, since the lengths of the assumed continuous fibers will vary from the lengths of the axial fibers (s) to those of the peripheral fibers ($s/\sin\theta$), the distribution about the axis corresponding to the square of the radius. Using (R) for the radius of the segment and (r) for the varying radii, the total length of all helices (Σh) is exhibited by equation (3).

$$\Sigma h = (sn/\pi R^3 \tan\theta) \int_0^R 2\pi r \sqrt{r^2 + R^2 \tan^2\theta}\ dr \quad \text{.....(3)}$$

and the average length (l_3) is shown in equation (4).

$$l_3 = 4\ sn \cdot \tan^2\theta\ (\csc^3\theta - 1)\ /3e \quad \text{.....(4)}$$

The differences in the values obtained by (1), (2) and (4) are relatively small and experiments with fibers of known length are closely in agreement with the theoretical values. Any factor for average fiber length will need a modifier, probably of an exponential nature, determined in connection with subsequent experimental work, since the increase in strength of yarns will not continue to be proportionate to the increase in fiber length.

The development of standards for materials along the lines suggested, presenting something more than arbitrary objective tests, is decidedly desirable under our present economic system. Such studies are now in progress.

The writer wishes to acknowledge his indebtedness to Dr. R. B. Allen, professor of mathematics at Kenyon College, and to Mr. Graham Walton, instructor in engineering at the University of Wisconsin, for assistance in connection with equation (3).

L. B. WALTON

KENYON COLLEGE

THE SYNTHESIS OF THE HEPTACETYL METHYL ESTER OF GENTIOBIURONIC ACID[1]

THE term "aldobionic acid" has come to be applied to those disaccharides containing a uronic acid as one of the component sugars. The aldobionic acids were first discovered among the products of hydrolysis of the specific polysaccharides of certain pathogenic microorganisms and have since been obtained from various plant gums. Apart from their chemical interest, there is evidence to believe that these sugar acids have an important function in determining the immunological specificity of encapsulated microorganisms.[2]

The chemical synthesis of aldobionic acids has awaited the development of the chemistry of the hexose-uronic acids. The recent preparation of the acetohalogen derivatives of glucuronic and galact-

[1] From the Hospital of the Rockefeller Institute for Medical Research, New York.

[2] W. F. Goebel, *Jour. Biol. Chem.*, 110: 391, 1935.

uronic acids[3] has made possible the synthesis not only of conjugated uronides but of aldobionic acids as well.

The synthesis of the β-heptacetyl methyl ester of the aldobionic acid, glucose-6-β-glucuronide, has been accomplished by condensing 1, 2, 3, 4-tetracetyl-β-glucose[4] with 1-bromo-triacetyl-glucuronic acid methyl ester in chloroform solution in the presence of silver oxide. The derivative is obtained in yields of 30 per cent. as a crystalline substance melting at 198–199° (uncorrected) and having a specific rotation in chloroform of $[\alpha]_D^{23} = -11.0°$ (C = one per cent.). (Found: C, 48.40; H, 5.48; OCH_3, 4.64; $COCH_3$, 46.1).

The β-heptacetyl methyl ester was converted into the α isomer by the action of zinc chloride in acetic anhydride solution. The α-heptacetyl methyl ester melts at 201–202° (uncorrected) and has a specific rotation in chloroform of $[\alpha]_D^{23} = +48.4°$ (C = 0.7 per cent.). (Found: C, 48.78; H, 5.58; OCH_3, 4.62; $COCH_3$, 45.4). The difference in molecular rotation of the α and β isomers is equal to 39,500 degrees, a value which is in good agreement with the known differences in molecular rotation of the α and β sugar acetates.

Since the aldobionic acid, glucose-6-β-glucuronide, can be regarded as the uronic acid derived from gentiobiose, the synthetic product described above may be designated as the heptacetyl methyl ester of gentiobiuronic acid. The latter substance is isomeric with the heptacetyl methyl ester of the aldobionic acid derived from the specific polysaccharide of Type III Pneumococcus. The application of analogous synthetic procedures should eventually make possible the preparation in the laboratory of aldobionic acids identical with those elaborated by encapsulated microorganisms in the production of their type-specific polysaccharides.

ROLLIN D. HOTCHKISS
WALTHER F. GOEBEL

[3] W. F. Goebel and F. H. Babers, *Jour. Biol. Chem.*, 111: 347, 1935; S. Morell, L. Baur and K. P. Link, *Jour. Biol. Chem.*, 110: 719, 1935.

[4] B. Helferich and W. Klein, *Ann. Chem.*, 450: 219, 1926.

[1] From the Laboratory of Neurophysiology, Yale University School of Medicine.

EXOGASTRULATION IN AMPHIBIA AFTER X-RAY EXPOSURE

THE following observations were made in the course of our studies upon regeneration and development as affected by irradiation. These investigations have been in progress for some years assisted by the Committee on Radiation of the National Research Council. In view of their general interest and because we have found no record of exogastrulation produced by x-rays, either in Amphibia or other groups, this note seems justifiable before histological study of the extensive series in hand and before completion of the further experiments now being conducted.

The exogastrulae, which are similar to those described by Holtfreter,[1] have been obtained by exposing blastulae to 1000 r, no filter, and allowing them to develop in tap water. Almost 100 per cent. exogastrulation has been observed after 1000 r, with about 50 per cent. exogastrulation following 500 r. Four series of Amblystoma, two of Rana and one of Bufo have given the same results. These exogastrulae live for only a few days and do not undergo extreme constriction at the blastopore region, as described by Holtfreter. Further experiments with reduced exposures are under way, and it is hoped that viable exogastrulae can be produced.

Control series in tap water included no exogastrulae. Other controls were placed inside the x-ray chamber under lead plates to test the effects of high concentrations of ozone generated by the x-ray machine. No abnormalities have been noted in the subsequent stages of blastulae thus exposed to ozone but protected from x-rays.

W. C. CURTIS
J. A. CAMERON
K. O. MILLS

ZOOLOGICAL LABORATORY
UNIVERSITY OF MISSOURI

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A PHOTOKYMOGRAPHIC METHOD WITH CONTINUOUS CATHODE RAY OSCILLOGRAMS[1]

THE method presented was developed during studies of action potentials from the nervous system. It gives photokymographic records of the cathode ray oscillogram, black, and other signals, white, on a gray background with coordinates of time and amplitude.

These have been obtained (4/10 actual size) on bromide paper moving vertically in a recording camera, fitted with a photographic lens of large aperture (F/1.2–5 cm focal length), set (11.5 cm) in front of the screen of the cathode ray oscillograph. On this the fluorescent spot moves horizontally in response to potentials impressed on the corresponding plates.

In the same focal plane tangent to the screen, just below the spot, is mounted a flat, horizontal strip of white, unglazed paper, illuminated by a washlight to

[1] J. Holtfreter, *Biol. Zentralblatt*, 53: 404–431, 1933.