phosphorus decreases in general from the D to the K fraction. The percentage of nitrogen, however, remains nearly constant throughout the present series. The exceptional properties of the very small K″ fraction appear due to contamination with specific polysaccharides,[5] especially since the other fractions are practically inactive toward an immune serum known to be rich in polysaccharide antibodies. The products differ in this respect from Johnson's "water soluble" and "alkali-soluble" tubercle bacillus proteins.[6] The relationship of the new fractions to the three proteins indicated by Levene[7] will be investigated.

The somewhat stronger precipitin reactions given by the fractions in an anti-timothy bacillus serum than in the homologous antiserum indicate that all contain group-specific protein. The only additional biological data available at the present preliminary stage of the study are that a proportion of normal rabbits showing a negative skin test to fraction K respond with a "lighting up" of the original test area during a subsequent course of intravenous injections of K, and, as found by Sabin and Smithburn at the Rockefeller Institute for Medical Research, a distinct difference in the type of skin reaction produced by the D and K fractions in tuberculous guinea pigs.

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INDUCTION OF EXPERIMENTAL GRANULAR CONJUNCTIVITIS BY DIRECT INOCULATION OF TRACHOMATOUS TISSUE

IN a recent review on the causation of human trachoma Dr. Bengtson[1] writes: "If it can be shown that the condition produced in *Macacus rhesus* monkeys by direct transfer from cases of human trachoma is as definite and as easily transmissible as that induced by inoculation with *Bact. granulosis,* then we would feel more certain of the relationship of *Bact. granulosis* to the human disease."

The observations herein reported demonstrate that direct transfer from such human cases is definitely and easily made and no difference exists between the readiness with which the experimental granular conjunctivitis can be induced by means of human tissue and culture of *Bact. granulosis.*

Through the kind cooperation of Dr. Martin Cohen, of New York, we obtained recently the tarsectomized conjunctival tissue removed for curative purposes from a case of florid trachoma of three years' duration, accompanied by bilateral pannus.

The specimen was employed in two ways: (a) For direct subconjunctival injection of one eye of monkeys having smooth lids, and (b) for bacteriological study. A culture of *Bact. granulosis* was isolated and it also was injected subconjunctivally in one lid of normal *Macacus rhesus* monkeys. Thus human trachomatous tissue, on the one hand, and a culture of *Bact. granulosis,* on the other, both having a common origin, were used to inoculate monkeys.[2]

The first two animals injected with the culture showed within seven days characteristic granular conjunctivitis in the inoculated eye. Within another week, the uninoculated conjunctivae became similarly affected, and after three weeks, the experimental disease, previously described in detail,[3] was fully developed. Conjunctival tissue was removed from one of the affected animals two weeks after inoculation, and employed for subconjunctival injection of two fresh monkeys; they in turn were apparently affected in the same way as the preceding animals. In this manner, monkey to monkey transmission was obtained through seven passages. At this point, when we were convinced that transfer could be carried on indefinitely, the experiment was terminated.

The first two animals inoculated with the suspension of human trachomatous tissue exhibited, within seven days, characteristic granular conjunctivitis, and again the tissue of one of them induced the experimental disease in two fresh animals. The affection was thus transmitted through seven consecutive series, at least, of paired animals. The period of incubation, the conveyance of infection from inoculated to uninoculated eye, the appearance of the early and fully developed lesions of the disease and the histopathological changes were identical with those shown by the animals of the culture series.

The activity of the incitant in both series apparently became "fixed" in the consecutive transmissions, that is, the incubation period and the degree of reaction became constant.

Since transfers were made early in the course of the affection, we were able to study the microscopic changes of beginning conjunctival lesions. These consisted of congestion of blood vessels and marked hypertrophy of their endothelium. The vessels were surrounded by a thick layer containing chiefly monocytes, some lymphocytes, and a few polymorphonuclear cells with acidophilic granules. In later stages, the perivascular agglomerations were coalesced to form the large folliculomata characteristic of trachomatous lesions.

[5] M. Heidelberger and A. E. O. Menzel, *Proc. Soc. Exp. Med. and Biol.,* 29: 631, 1932.
[6] T. B. Johnson, *Am. Rev. Tuberc.,* 14: 169, 1926.
[7] P. A. Levene, *Medical Record,* Dec. 17, 1898.
[1] I. A. Bengston, Public Health Rep., 47: 1914, 1932.
[2] All operative procedures were carried on with the aid of ether anesthesia.
[1] H. Noguchi, *Jour. Exp. Med.,* 48, Suppl. 2, 53 pp. 1928; P. K. Olitsky, R. E. Knutti and J. R. Tyler, *Jour. Exp. Med.,* 53, 753, 1931; 54, 31, 1931.

Finally, cultures of *Bact. granulosis* were isolated from monkeys of the first and second passages of the series of transmissions initiated by inoculation of trachomatous tissue, and from animals of the third and sixth passages of the *Bact. granulosis* series.

In conclusion, we have found that the experimental disease induced by human trachomatous tissue is as definitely transmissible as that produced by cultures of *Bact. granulosis,* and that from different animals of both series the microorganism can be recovered. We also record the fixed character of the incitant in consecutive animal passages and the anatomical changes of early experimental lesions.

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ROD-SHAPED PARTICLES IN TOBACCO MOSAIC VIRUS DEMONSTRATED BY STREAM DOUBLE REFRACTION

FOR some years pathologists have been attempting to obtain evidence regarding the nature of the filterable viruses which cause numerous diseases of man, lower animals and plants. Although much information has been gained regarding the properties of viruses the available evidence is still insufficient to prove whether the virus particles are inanimate colloids or organisms which are too small to be seen through the microscope.

We have recently attempted to obtain evidence regarding the shape of virus particles by the use of polarized light. Methods somewhat similar to those described by Ambronn and Frey[1] and Freundlich[2] for determining the shape of colloid particles have been used in this work. According to these workers minute isotropic rods, disks or leaf-shaped particles contained in a flowing liquid tend to become oriented with their long axis parallel to the direction of flow. Under these conditions a liquid containing rods is doubly refractive when the direction of transmission of the incident light is perpendicular to the direction of flow; a liquid containing disks or leaf-shaped particles is doubly refractive when the incident light is perpendicular to the direction of flow and parallel to the faces of the particles. This so-called form double refraction only occurs when the dispersed phase has a refractive index which differs from that of the continuous phase and when the shortest axis of the particle is small in relation to the wave-length of the light used. Liquids containing anisotropic rods, disks or leaf-shaped particles also show form double refraction under the above conditions, and in addition to this may show an intrinsic double refraction due to the arrangement of atoms in the particles. This intrinsic double refraction occurs when the anisotropic particles are so oriented that their long axis is parallel to the direction of flow, and the direction of transmission of the incident light is not parallel to the optic axis of the particles. Since most of the studies which have been made on virus particles indicate that they are smaller than the wave-lengths of visible light it appears that if virus particles were to have the form of rods, disks or leaves, and the proper refractive index, and were in sufficient concentration, the flowing virus suspension should show double refraction.

In order to test this idea the apparatus shown in Fig. 1 was set up. It consists of an ordinary microscope lamp L and a microscope stand S, from which

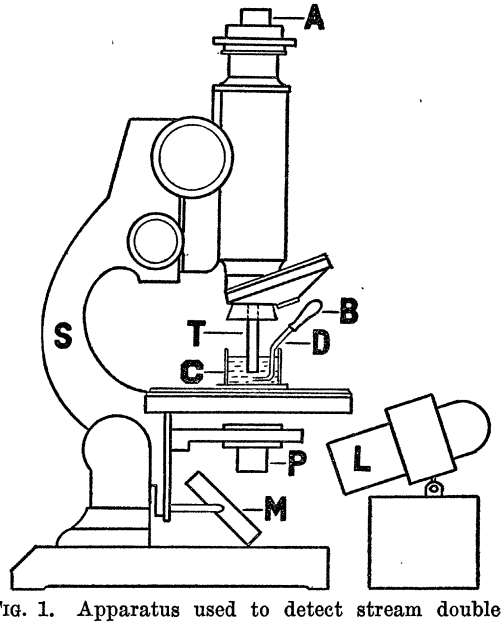

FIG. 1. Apparatus used to detect stream double refraction in virus-containing plant juices and other sols.

the ocular, objectives and condenser have been removed. A polarizer P was placed in the diaphragm carrier and an analyzer A was attached to the microscope tube. A curved glass pipette D, having an inside diameter of 0.5 mm at the orifice, was prepared. This was cemented to the inside of a cylindrical glass chamber C, with its orifice so directed that pressure on the bulb caused a stream to flow across the middle of the chamber. A small round cover glass was cemented to the lower end of the glass tube T, and the upper end of the tube was pushed through a hole in a rubber stopper. The stopper was held in one of the

[1] H. Ambronn and A. Frey, "Das Polarisationsmikroskop." Leipzig. 1926.

[2] H. Freundlich, "Colloid and Capillary Chemistry." E. P. Dutton and Co., New York.