tral or acid formalin or ethyl alcohol and more slowly in chromate fixing solutions.

Conclusions. The addition of a large quantity of ground psyllium seed to the diet of albino rats or dogs is followed by a darkening of the kidneys when examined grossly. If the feeding is continued for a longer period brown pigment granules become evident microscopically in the renal tubules. Whole psyllium seed produces no renal pigmentation.

6402

Method for Determining Shape of Colloidal Particles; Application in Study of Tobacco Mosaic Virus.

WILLIAM N. TAKAHASHI AND T. E. RAWLINS.
(Introduced by T. D. Beckwith.)

From the Division of Plant Pathology, University of California, Berkeley, Calif.

According to Freundlich,[1] when a sol containing rods, discs, or leaf-shaped colloidal particles is flowing through a tube the particles become oriented with the longest axis of the particles parallel to the direction of flow. Discs or leaf-shaped particles near the walls of the tubes also tend to be oriented with their faces parallel to the adjacent wall. Ambronn and Frey[2] reported that sols containing rod-shaped particles are doubly refractive when the particles are oriented by streaming and the direction of observation is perpendicular to the direction of flow. Sols containing discs or leaf-shaped particles show double refraction when the longest axis of the particles is parallel to the direction of flow and the faces of the particles are parallel to the direction of observation.

The above phenomena led us to assume that if a sol containing rod-shaped particles were forced from a small glass tube of circular cross section into the same sol contained in a beaker the orientation of the particles should be the same throughout the stream and all parts of the stream should, therefore, show double refraction. If the direction of flow were reversed and the sol were sucked from the beaker through the small glass tube the sol in the beaker should flow radially toward the mouth of the tube as a center and the long

[1] Freundlich, Colloid and Capillary Chemistry, 1922, E. P. Dutton & Co., N. Y.

[2] Ambronn and Frey, *Das Polarisationsmikroskop*, 1926, Akademische Verlags gesellschaft M. B. H. Leipzig.

axis of the particles should be oriented parallel to the directions of flow. All regions of the sol in the beaker which are flowing toward the mouth of the tube would be expected to show double refraction except those regions which are flowing parallel to the vibration directions of the crossed nicols. A dark cross should, therefore, be observed in the doubly refractive sol which is flowing toward the mouth of the tube. If a sol containing discs or leaf-shaped particles were forced from the small glass tube the long axis of the particles should be parallel to the direction of flow but only the particles near the lateral walls of the tube would have their faces parallel to the direction of observation. Therefore double refraction would be expected only near the edges of the stream. If the direction of flow were reversed, one should expect that neither double refraction nor a dark cross would be detected in the sol flowing toward the mouth of the tube, since the faces of the particles would not be oriented relative to the direction of observation.

In order to test these hypotheses, sols whose particle shape had been determined by Freundlich[1] and his associates by the application of the Tyndall method, were forced from a small tube (inside diameter 0.5 mm.) into a beaker and were then sucked from the beaker back through the tube. It was observed that vanadium pentoxide, aniline blue, and benzopurpurin sols showed double refraction throughout the stream when forced from the tube and also exhibited double refraction and the dark cross when sucked toward the mouth of the tube, thus showing the behavior which would be expected of sols containing rod-shaped particles.

On the other hand, a ferric oxide sol was found to show double refraction only along the edges of the stream when forced from the tube. Neither double refraction nor a dark cross were observed when the sol was sucked toward the mouth of the tube. As stated above, this is the behavior which would be expected of sols containing discs or leaf-shaped particles.

Freundlich[1] reported that studies involving the application of the Tyndall phenomenon have indicated that vanadium pentoxide, aniline blue, and benzopurpurin sols contain rod-shaped particles and that ferric oxide sols contain discs or leaf-shaped particles. Since the principles involved in the Tyndall method are different from those involved in the stream double refraction method, and since the two methods have led to the same conclusions regarding the shape of the colloidal particles which were studied, it appears that the latter method is probably reliable for determining the shape of particles in sols which exhibit stream double refraction.

Up to the present time no evidence has been available regarding the shape of the particles of the various filterable viruses. We have attempted to determine the shape of tobacco mosaic virus particles by the use of the stream double refraction method and have found that suspensions of the virus showed double refraction throughout the stream when forced from a small tube and exhibited double refraction and the dark cross when sucked toward the mouth of the tube. Juice from healthy plants exhibited no double refraction when forced from the tube or when sucked toward the tube. This experiment was repeated a number of times with juice from different portions of tobacco plants and with tomato plants infected with the same virus. In all cases the juice from infected tissues showed the same type of stream double refraction and the juice from uninfected tissues failed to show detectable double refraction.

The evidence therefore indicates that the virus of tobacco mosaic, or some substance regularly associated with it, is probably composed of rod-shaped particles.