DISCUSSION AND CORRESPONDENCE

BACTERIAL FILTERS AND FILTERABLE VIRUSES

DR. S. P. KRAMER'S experiments with bacterial filters and filterable viruses, printed in SCIENCE for January 14, 1927, lead me to draw more general attention to some work of Professor Richard Zsigmondy (recent Nobel prize winner), to which I referred in a discussion at the A. A. A. S. meetings in Philadelphia. In Chapter XIV, on "Filtration Experiments," of his book "Colloids and the Ultramicroscope" (Wiley & Sons, 1909), he says:

All three kinds of filters (Maassen, Pukall and Chamberland) contain pores large enough to allow the passage of gold particles of about 30 μμ and less. The pores of a cell are of very different sizes, the Chamberland cell containing, for example, large pores, which allow the gold particles to pass through, and others which retain most of them. The size of the pores is, however, not the sole criterion in filter experiments. It is of especial importance in coarse filters, whether the particles to be filtered are held to the surface of the cell by adhesion or "adsorption" (A), or not (B).

(A) In the first instance the substance to be filtered gathers upon the outside surface (and to a certain extent in the deeper pores), and prevents the other particles from forcing their way through; first, because the pores are made smaller; second, because the particles held fast to the surface of the cell repel the freely moving particles following the course of the current.[1]

(B) When adhesion or adsorption does not take place, all colloidally dissolved substances pass freely through the cell, providing the pores are large enough.

In the presence of a protective colloid, *e.g.*, egg albumen, all the gold particles pass smoothly through, whereas in the absence of protectors, matters proceed as in case (A). The fact that protected gold particles of 30 μμ and over easily pass through Maassen and Pukall filters should be of interest to bacteriologists. The Chamberland filter, too, contains, besides the very small pores chiefly present, others which permit the passage of particles of the size mentioned.

Another point of great importance to bacteriologists has been emphasized by Professor H. Bechhold, who found that lecithin emulsions whose droplets were several μ in diameter passed through ultrafilters capable of retaining hemoglobin, and whose pores were less than 30 μμ (pressure 150 g./cm²). Bechhold explains that the droplets assume a filiform shape in their passage, reforming on their exit.[2]

[1] This action may be due to the well-known negative electric charge of the particles, which apparently also affects the adhering gold particles.

[2] See Bechhold's "Colloids in Biology & Medicine," Bullowa's translation, Van Nostrand; also Vol. I of Alexander's "Colloid Chemistry, Theoretical and Applied," Chem. Cat. Co., 1926, articles on Ultrafiltration and Electro-ultrafiltration by Bechhold.

Bechhold says in the latter reference, p. 832:

Therefore the diameter of the pores of the ultrafilter gives no definite idea of the diameter of a retained particle as far as *emulsions* are concerned, whose disperse phase has a low surface tension against the dispersing phase.

Since the work of Heilbronn, Chambers, Seifriz and others shows the great changes in viscosity which organisms exhibit during mitosis, and since changes in the milieu may produce similar changes, we must observe many precautions before hazarding an opinion about size deduced from filtration experiments. Alteration of the pH of the milieu may modify the charges of particle and of filter, and even reverse them. Salt ratios and antagonism must be considered, as well as anything leading to formation of surface films. And these or other factors may influence the viscosity of protoplasm. Professor H. Schade illustrates a phagocyte passing in filiform fashion through an orifice very much less than its average diameter, and appearing in its usual guise after it emerges on the other side of the membrane.

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PUBLICATION BY PHOTOGRAPHY

IN SCIENCE for December 31, Professor Albrecht discusses the use of photographic reproductions of typewriting in scientific publication, and mentions the difficulty of the irregular spreading of ink on the typewritten sheet. Some years ago I had occasion to publish (*American Journal of Psychology,* 29, 1918, p. 120) a 4-page psychophysical table and, wishing to obtain a clear reproduction and yet to avoid the expense of having so extensive a table set up in type, resorted to the following method which may be of interest in this connection:

The ribbon was temporarily removed from the typewriter, or set as for stencil cutting. The sheet of paper upon which the table was to be typed was covered with a sheet of carbon paper and placed in the machine. As the typing proceeded each key impinged directly upon the back of the carbon paper and made an impression from the latter on the white paper. The result was a remarkably clear reproduction, which photographed well with about 2:3 reduction and which is quite legible in the final printed form. This method is somewhat more difficult than typewriting with a ribbon, as the typist can not see what she is writing. All errors were corrected by pasting over the mistake a piece of paper with the correct figures. A new sheet of carbon paper must, of course, be used for every page. The increased