

to prevent the escape of CO₂, the fluid was not allowed to come into contact with the air.

Results.—The reactions of 16 joint exudates from patients with acute rheumatic fever were all slightly alkaline; their hydrogen-ion concentration varied from P_H 7.2 to 7.38. Seven exudates from patients with chronic arthritis varied in P_H from 7.27 to 7.4. An exudate aspirated from a knee infected with *Staphylococcus aureus* had a P_H of 6.63 and that from a knee infected with *Streptococcus hæmolyticus* was also acid, having a P_H of 6.14.

Since a definitely acid medium is necessary for the liberation of salicylic acid, and since all of the joint exudates from acute rheumatic fever patients were slightly alkaline, no free salicylic acid can exist in these joint fluids following the administration of salicylates.

127 (1874)

The selective bactericidal effect of acid fuchsin and sodium chloride.

By JOHN W. CHURCHMAN.

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In 1912 it was found that if bacteria be stained with gentian violet and planted on plain agar a sharp selective activity of the dye could be readily demonstrated. All the commoner gram-negative organisms survived even long exposure to the stain, while all the commoner gram-positive spore-bearing aërobes were "killed," even by a relatively short exposure. Even the spores—though not deeply, if at all, stained by gentian violet—were "killed" by exposure to the dye. What was true of gentian violet was found to be true also of other *basic* dyes of the tri-phenyl-methane group.

It is now found that a cleavage in exactly the opposite sense occurs if organisms be exposed to acid fuchsin—an *acid* dye of the tri-phenyl-methane series. Whereas gentian violet kills the gram-positive spore-bearing aërobes and spares the commoner gram-negative bacteria, acid fuchsin spares the former and kills

the latter. The experiments on which this statement is based were done with *B. subtilis*, *B. megatherium*, *B. anthracis*, *B. typhosus*, *B. coli communis*, *B. prodigiosus*, *B. pyocyaneus*, *B. proteus vulgaris*. In the case of gentian violet the reaction is evident if the stain is applied to the organisms at room temperature; but in the case of acid fuchsin, while long exposure to the dye at room temperature produces the reaction, a slight increase in temperature (to 45° C.) makes it much sharper and speedier.

In the case of gentian violet it was shown, by a study of the whole bacterial field, that the gentian-violet reaction and the gram reaction ran parallel in a striking way. Not only did the cleavage hold between gram-negative organisms and the commoner *spore-bearing aërobes*; it also held between gram-negative bacteria and the great majority of *non-spore-bearing gram-positive organisms*. That a reverse parallelism holds for acid fuchsin has not been proven. Of the greater susceptibility to this dye of the gram-negative organisms (as compared with the gram-positive *spore bearers*) there is no doubt; it is not established that a similar cleavage holds between gram-negatives and gram-positive *non-spore bearers*. An interesting practical point is the susceptibility of the gram-negative *B. pyocyaneus* to acid fuchsin; this organism is often a great nuisance in open wounds and resists ordinary antiseptics.

What has been said of acid fuchsin is true also of another and wholly unrelated acid dye—ponceau P.R. It is also true of sodium chloride. When the commoner gram-negative organisms are exposed to saturated solutions of any of these three substances at 45° C., they are killed; while gram-positive spore bearers are unaffected under similar conditions. This is the exact reverse of the behavior of these two classes of bacteria toward basic gentian violet.

In the case of gentian violet, the selective effect of the dye may be demonstrated either by staining the organisms and planting them on plain agar or by planting them unstained on agar containing the dye. The gram negatives grow well in the presence of the dye, while the gram positives will not grow at all, even when the stain is present in the media in very small amounts. For this and other reasons the activity of the dye has been referred to

as bacteriostatic, since it seems to consist essentially in an inhibition of growth. It is probable that this parallelism between the bacteriostatic and the bactericidal activity of the dye, so clear cut in the case of gentian violet, does not hold in the case of acid fuchsin and sodium chloride. The evidence thus far gathered would indicate that the mechanism by which growth is inhibited may be entirely different from the mechanism by which organisms are killed.

128 (1875)

On the method of macronuclear disintegration during endomixis in *Paramecium aurelia*.

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In the original studies¹ of the nuclear phenomena involved in endomixis, it was found that macronuclear disintegration, both in *Paramecium aurelia* and *Paramecium caudatum*, was effected by the elimination of spherical chromatin-bodies from the macronucleus, instead of by the transformation of most of the macronucleus into long tangled chromatin-ribbons such as occurs during conjugation in these species. Regarding *Paramecium aurelia*, it was stated that the "differences between the macronuclear changes during conjugation and during the process (endomixis) are only morphological; on the one hand, the macronucleus forms 'wurstförmige Schlingen,' while on the other, the macronucleus eliminates its chromatin by extruding it in the form of spherical bodies."²

This contrast proved valid not only in Woodruff's pedigree race³ (I) of *Paramecium aurelia* in which endomixis was discovered, but also in animals from such diverse sources as Germany and Ohio. Only one cell (*Paramecium aurelia*, I), 4087th generation, Decem-

¹ L. L. Woodruff and Rhoda Erdmann, *Journ. Exper. Zoölogy*, 1914, xvii, 425-517. Erdmann and Woodruff, *Journ. Exper. Zoölogy*, 1916, xx, 59-97.

² Woodruff and Erdmann, loc. cit., pp. 438-39, and 444; Plate 1, Figs. 9 and 11; Plate 2, Fig. 14; Plate 3, Fig. 32.

³ Woodruff, *Biological Bulletin*, 1917, xxx, 51-56.