tained, under different conditions of growth. If, however, several preparations of the same substance are examined, and the AL/AB ratios compared, definite evidence may be forthcoming. Thus in Table I the activities of 3 preparations of clavacin or sodium clavacinate are shown. These show antibacterial activities varying nearly 10-fold, but the AL/AB ratios are identical. This would indicate that the antiluminescent activity of clavacin might be due to a constantly present impurity, but is more probably inherent in the substance itself. Decrease in the AL/AB ratio with increasing purification would indicate that the antiluminescence was due to an impurity; increase in the ratio, that the antibacterial activity was due to an impurity.

It is clear that the antibiotic substances divide themselves into groups on the basis of their AL/AB ratios (Table I). While no clear cut divisions occur there is marked difference between penicillin or the products from soil bacteria with their very high ratios on the one hand, and tolu-p-quinone or pyocyanase with very low ratios on the other.

The results obtained with penicillin will be considered more fully elsewhere.[8] It is clear from Table I, however, that penicillin in purified form has no antiluminescent activity under the conditions of the test as described here. Because of its high antibacterial activity, however, it does affect the *Photobacterium fischeri* itself and causes gradual disappearance of luminescence over a long period of observation.

Summary. The power to inhibit the bioluminescence of luminescent bacteria has been shown to be possessed by antibiotic agents other than those derived from fungi and actinomycetes. Amongst the antibiotic substances newly shown to have such activity are some obtained from bacteria as well as others which are derived from fungi, and still others which are pure chemicals. An antiluminescent-antibacterial ratio has been obtained for all of the substances tested and its significance is discussed.

8 McKee, C. M., and Rake, G., to be published.

14061

Germicidal Action of Aliphatic Alcohols.

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Several investigators have compared the bactericidal properties of the aliphatic alcohols. Wirgin[1] and Stadler[2] reported that the disinfecting action of the alcohols corresponded to an increase in their molecular weights, with the exception of the tertiary alcohols. None of the alcohols could kill spores at room temperature. Kokko[3] confirmed the previous reports and observed that among isomers toxicity showed the following order: primary > iso- > secondary > tertiary. Preliminary experiments to determine the action of 12 different concentrations of ethyl alcohol on *Staphylococcus aureus* (2 strains), *Aerobacter aerogenes* (2 strains), *Serratia marcescens* (2 strains), *Eberthella typhosa* (2 strains), *Escherichia coli* (2 strains), *Bacillus megatherium, Bacillus subtilis* (2 strains), *Saccharomyces cerevisiæ* and *Monilia albicans* indicated that all nonsporeforming bacteria tested were destroyed in any percentage of the alcohol between 100% and 45% in 5 minutes, while the yeasts and 2 strains of *Eberthella typhosa* were destroyed by 35% alcohol and above. The sporeforming organisms were not affected.

The next set of experiments was concerned

1 Wirgin, G., *Z. Hyg. und Infekt.*, 1904, **46**, 149.

2 Stadler, H., *Arch. Hyg. und Bakt.*, 1911, **73**, 195.

3 Kokko, U. P., *Arch. Hyg. und Bakt.*, 1939, **122**, 44.

with the longevity of sporeforming organisms in aliphatic alcohols. With ethyl alcohol the greatest decrease in organisms occurred in the 65% solutions, but complete destruction was not observed in any percentage. *Bacillus subtilis* and *Bacillus megatherium* were found to be viable after 9 months of contact with 100% primary normal methyl, ethyl, propyl, butyl, amyl, hexyl, heptyl, octyl, nonyl, and undecyl alcohols.

The last experiments were undertaken to compare action on bacteria of members of the aliphatic alcohol series. The procedure was similar to the agar cup plate method of testing antiseptics and disinfectants proposed by L. C. Himebaugh and described by Reddish.[4] *Staphylococcus aureus* (2 strains), *Serratia marcescens, Pseudomonas aeruginosa, Escherichia coli* (2 strains), *Bacillus megatherium* and *Bacillus subtilis* were the organisms used. From the aliphatic alcohol series samples of the following alcohols were tested: methyl, ethyl, n-propyl, iso-propyl, pri.-n-butyl, pri.-iso-butyl, sec.-n-butyl, tert.-butyl, n-amyl, pri.-iso-amyl, act.-amyl, sec.-n-amyl, methyl-iso-propylcarbinol, tert.-amyl, pri.-n-hexyl, 2-ethyl-n-butyl, 2-methyl-pentanol-1, methyl-iso-butyl-carbinol, di-methyl-iso-propylcarbinol, pri.-n-heptyl, methyl-n-amylcarbinol, di-iso-propylcarbinol, pri.-n-octyl, methyl-n-hexylcarbinol, pri.-n-nonyl and pri.-n-undecyl. Above the undecyl alcohols the compounds are not liquid at 20°C, thus rendering their use impractical. The agar cup plates were examined after 48 hours and one week of incubation at 37°C.

The radii of the clear areas surrounding the cups which contained the disinfectants being tested were measured. Methyl alcohol did not noticeably affect the growth of surrounding organisms, while ethyl alcohol produced an inhibition zone of 1.0-1.5 mm. There was an increase in the clear areas corresponding to the increase in molecular weights of the alcohols as far as amyl alcohol, which caused an average inhibition of bacterial growth for a radius of 44 mm. The clear zones were slightly decreased in the primary-normal hexyl, heptyl, and octyl alcohols, respectively, ranging from 43 to 37 mm. The last alcohol tested, primary normal undecyl, was comparable to ethyl alcohol in its effect upon growth of the bacteria used.

After the 48-hour observation, broth subcultures were made from the clear zones to determine if the organisms were merely inhibited or actually killed. The broth tubes were incubated for one week at 37°C and examined for turbidity. The observations made confirm the results noted in literature reviews as far as they have been reported in the aliphatic series. The results in the present experiment conform to the rule from the methyl to the amyl alcohol group. Primary-normal-amyl alcohol appears to show the maximum destruction of organisms, but after that there is a slow decrease through the primary-normal-hexyl, heptyl, and octyl alcohols. Between the primary-normal-octyl and the primary-normal-nonyl alcohols there is a considerable drop in germicidal action, and the primary-normal-undecyl alcohol is nearly as low as ethyl alcohol. In the case of *Pseudomonas aeruginosa* there is actual stimulation of growth rather than inhibition in the undecyl alcohol sample. Throughout the series the primary-normal, primary-iso-, secondary-normal and tertiary alcohols, respectively, decrease in germicidal value for the organisms which were used. Normal-propyl alcohol was the most effective of the water soluble alcohols.

The strains of *Staphylococcus aureus* and *Bacillus subtilis* were much more resistant to all of the alcohols tested by the agar cup plate method than the strains of *Serratia marcescens, Escherichia coli* and *Bacillus megatherium* which were used.

There is a rapid decrease in solubility corresponding to the increase in molecular weight of the compounds which may have had a direct effect upon the results of this experiment. The actual area of the inhibition zone may have been determined by the penetrability and solubility of the compound tested, as well as by its germicidal properties.

Summary. Twenty-six aliphatic alcohols containing from one to 11 carbon atoms were compared in their disinfecting action against nine representative strains of bacteria. Pri-

[4] Reddish, G. F., *J. Lab. and Clin. Med.*, 1929, **14**, 649.

mary-normal-amyl alcohol was found to be the most effective disinfectant when tested by the agar cup plate method for testing antiseptics and disinfectants. There was a regular decrease in germicidal action from the primary to iso- to secondary to tertiary arrangements of the carbon atom chain for any given number of carbon atoms.

14062

Relation Between Ovarian Function and Avidin Content in the Oviduct of the Hen.

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The dietary studies of Boas[1] and of Parsons[2] demonstrated that raw egg-white contains a factor capable of producing in rats and other species a specific toxic syndrome. This condition is characterized in rats by a scaly dermatitis, loss of hair, reduction in weight, diarrhea, spasticity of the hind limbs, and a general debility which ultimately leads to death. The harmful agent in egg-white has been shown by Eakin *et al.*[3] to exert its toxic effect by rendering the biotin in the diet unavailable to the animal. Because of this affinity for biotin, the egg-white injury factor has been named "avidin."[3]

Biotin, originally considered only as a growth-essential for yeast, has subsequently been identified as the dietary factor which either prevents or cures egg-white injury.[4] Biotin was first isolated from dried egg yolks by Kögl and Tonnis[5] and its chemical structure has been elucidated recently by du Vigneaud.[6] It is particularly noteworthy that the chicken is among those species shown to require biotin for growth and survival.[7,8]

Hertz and Sebrell[9] have recently presented evidence indicating that avidin arises as a secretory product of the mucosa of the oviduct of birds and amphibia. We wish to present at this time further data concerning the relationship of avidin content of the oviduct to the functional state of the ovary of the hen. In addition, we have attempted to determine more specifically the particular tissues of the oviduct which are concerned with avidin secretion.

Material and Methods. Thirty-one adult hens weighing between 2 and 3 kg were maintained in separate cages on an adequate stock diet. Of the 21 laying birds, 8 were sacrificed at known times following estimated time of ovulation in order to obtain the oviducal egg at various levels in the magnum. Eight hens were autopsied immediately following lay; the 5 remaining hens carried eggs *in utero* at autopsy. Ten non-laying hens, seasonally out of production, were sacrificed to provide oviducts in varying degrees of atrophy.

The avidin content of the various oviducal tissues was determined by the method of Eakin *et al.*[10] as modified by Hertz.[11] This method

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1 Boas, M. A., *Biochem. J.*, 1927, **21**, 712.

2 Parsons, H. T., *J. Biol. Chem.*, 1931, **90**, 351.

3 Eakin, R. E., McKinley, M. A., and Williams, R. J., *Science*, 1940, **92**, 224.

4 György, P., Rose, C., Hoffmann, K., Melville, D. B., and du Vigneaud, V., *Science*, 1940, **92**, 609.

5 Kögl, F., and Tonnis, B., *Z. Phys. Chem.*, 1936, **43**, 242.

6 du Vigneaud, V., *Science*, 1942, **96**, 455.

7 Hegsted, D. M., Oleson, J. J., Mills, R. C., Elvehjem, C. A., and Hart, E. D., *J. Nutr.*, 1940, **20**, 599.

8 Ansbacher, S., and Landy, M., PROC. SOC. EXP. BIOL. AND MED., 1941, **48**, 3.

9 Hertz, R., and Sebrell, W. H., *Science*, 1942, **96**, 257.

10 Eakin, R. E., Snell, E. E., and Williams, R. J., *J. Biol. Chem.*, 1941, **140**, 535.

11 Hertz, R., PROC. SOC. EXP. BIOL. AND MED., 1943, **52**, 15.