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REHABILITATION AND THE COLLEGE CURRICULUM IN BIOLOGY[1]

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PROPOSED and existing federal legislation concerned with education provides a fairly good index to the general concepts and major plans for American postwar instruction. In addition to the existing laws for the rehabilitation and training of veterans (Public Laws 16, 1943 and 346, 1944), there are pending, and apparently certain of early enactment into law, three other important federal bills on education. These include the General Aid Bill (S-637), the Vocational Education Bill (S-1946) and the College and University General Extension Act (S-1670). The General Aid Bill aims to equalize educational opportunities in public schools through federal subsidy to inadequately financed institutions. The Vocational Education Bill contemplates an initial appropriation of $97,500,000 for vocational training, essentially on a post-high-school level, of veterans, displaced war workers and adults. The General Extension Act will grant funds to state universities and land-grant colleges for extension and adult education supplemental to agricultural extension work. The foregoing bills are the outgrowth of various nation-wide studies to meet the probable postwar educational needs of major groups of our population. Federal legislation of the above type is already being supplemented by similar laws in individual states.

These proposals clearly indicate that our schools, especially colleges and universities, face the task of serving a very large and extremely heterogeneous body of students. The traditional pattern of college curricula hitherto designed to serve primarily the needs of relatively immature high-school graduates will have to be modified for battle-hardened veterans and mature

[1] Address before the Botanical Society of America, at the meeting of the American Association for the Advancement of Science in Cleveland, Ohio, September 11, 1944.

5 and 7.5 mg per ml brought about 30 per cent. and 69 per cent. inhibition, respectively. Inhibition exerted by a mixture of methionine and penicillin was roughly the sum of inhibition obtained with each ingredient separately. Thus, 7.5 mg of methionine and 3.5 O. U. of penicillin giving each separately 69 and 40 per cent. inhibition, respectively, induced 100 per cent. inhibition when used together. The finding is of interest for the following reason. It was previously demonstrated that penicillin produced its effect during the stage of active bacterial multiplication. Agents inhibiting growth interfered with penicillin activity (*i.e.*, cold, saline, phenol, sulfadiazine, etc.).[7] In contrast, the combined effect of methionine and penicillin was clearly synergistic.[8] Since methionine is non-toxic *in vivo*, its use in conjunction with penicillin therapy of *E. coli* infections seems worthy of consideration. However, prior to these attempts it was deemed advisable to determine the effect of blood serum upon the concerted action of the agents, as follows:

Combined effects of blood serum, methionine and penicillin upon growth of E. coli: Preliminary tests demonstrated the well-known inhibitory effect of normal blood serum upon *E. coli*. The concentration of inhibitory factors varied considerably in fresh rabbit sera tested. Greatest inhibition obtained with filtered sera stored for 24 hours at 4° C prior to use was 20 and 40 per cent. when they were diluted 1:10 and 1:5, respectively, in broth containing 1.5×10^5 cells per ml.[9] Most of studies described below were carried out with sera of lower bactericidal potency than just mentioned. Penicillin, 3.5 O. U. per ml combined with some batches of sera diluted 1:6.67 gave 100 per cent. inhibition, while each ingredient separately gave 40 and 30 per cent., respectively. It appeared that the inhibition caused by the mixture exceeded the sum of inhibition produced with each ingredient separately. Suggestively, one of the ingredients may be capable of enhancing the susceptibility of *E. coli* to the effect of the other. This observation awaits further investigation.

The toxic effect of methionine alone upon *E. coli* described above was abolished by blood serum reducing up to 80 per cent. the inhibitory effect of 7.5 mg of methionine per ml. The neutralizing property varied in concentration. It could be clearly demonstrated in sera of low bactericidal titer.[10]

The most interesting fact in these studies is that serum-methionine mixtures, by themselves of low inhibitory potency, may enhance greatly the susceptibility of *E. coli* to penicillin. Thus, penicillin in concentration of 0.5 to 1.5 O. U. per ml gave 100 per cent. inhibition of 1.5×10^5 cells per ml at zero hours in broth containing 7.5 mg methionine and sera diluted 1:8. The mixture of the same ingredients without penicillin gave only 12–25 per cent. inhibition. In the absence of the serum-methionine mixtures, 0.5 O. U. of penicillin gave no inhibition and 1 to 1.5 O. U. only slight inhibition; 18 O. U. being required for complete inhibition of the above number of cells at zero hours. Obviously, serum-methionine mixtures were capable of increasing the susceptibility of *E. coli* to penicillin as many as 12 to 36 times.

Summary: Within a certain range, there exists a linear relationship between the log of *E. coli* cells at zero hours and the concentration of penicillin in O. U. per ml. required to produce complete inhibition. Methionine inhibits the growth of *E. coli*. Methionine and penicillin exert together a synergistic inhibitory effect upon the microorganism. Inhibition of growth obtained with a mixture of rabbit blood serum and penicillin may exceed somewhat the sum of inhibition induced by each ingredient, separately. The inhibitory effect of methionine alone may be abolished in considerable part by blood serum.

"Neutralized" mixtures of methionine and serum producing by themselves only incomplete inhibition may greatly increase the susceptibility of *E. coli* to penicillin.

GREGORY SHWARTZMAN

[7] M. H. Dawson, *et al.*, *Jour. Clin. Invest.*, 1941, 20: 434, 1941; G. L. Hobby and M. H. Dawson, *Proc. Soc. Exp. Biol. and Med.*, 56: 178 and 181, 1944; C. P. Miller and Foster A. Zimmerman, *Proc. Soc. Exp. Biol. and Med.*, 56: 205, 1944.

[8] There are no additive effects of sulfanilamide and methionine. On the contrary, sulfanilamide appears to neutralize the antibacterial action of methionine (see footnote 5).

[9] Sera separated from coagulated heart blood were sterilized by filtration through Berkefeld N candle, stored in the refrigerator and used 24 hours following preparation.

[10] J. Gordon and J. W. M'Leod reported that the inhibitory effect of a number of amino acids may be abolished by serum. Methionine was yet unavailable. J. Gordon and J. W. M'Leod, *Jour. Path. and Bact.*, 1926, 29: 13, 1926.

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