The significance of this process for the production of phosphopyruvic acid by the oxidation of lactic acid, and the mechanism of the phosphorylation, are being studied.

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CHEMOTHERAPY IN EXPERIMENTAL INFECTIONS CAUSED BY STREPTOBACILLUS MONILIFORMIS

STREPTOBACILLUS moniliformis is constantly associated with a pleuropneumonia-like organism[1] which may represent a phase in the life history[2] of the *Streptobacillus moniliformis*. In view of a report that gold compounds are effective against infections produced with certain pleuropneumonia-like organisms in rats and mice,[3] it was considered of interest to see whether or not these compounds would also affect experimental infections induced by *Streptobacillus moniliformis*. Such has proved to be the case.

The intra-abdominal injection of Swiss mice with moderate amounts of virulent young cultures of *Streptobacillus moniliformis* causes septicemia resulting in death, usually in from one to three days. The injection of minute amounts of virulent cultures or moderate amounts of old or attenuated cultures frequently causes arthritis involving one or more joints. The virulence of cultures is subject to fluctuations, so that all therapeutic experiments must be well controlled. The microbes used in these experiments were contained in young cultures grown on veal infusion broth containing 20 per cent. horse serum. Swiss mice weighing approximately 20 gm were used and were found to be more susceptible to the infection than a strain of white mice of mixed origin. The gold preparation used was gold sodium thiomalate (myochrysine), which was administered intramuscularly in one dose, usually at the time of the injection of the bacterial culture. A single dose of 0.25 gm of the drug per kilogram of weight of the mouse, administered at the time of injection of the microbic culture, or twelve hours before or after, was effective in protecting against from 100 to 1,000 times the least amount of culture necessary to cause death in four out of five mice within three days.

Individual experiments consisted in the intra-abdominal injection of a given amount of bacterial culture into ten mice and treating five of these mice with the aforementioned drug. The mice were observed for at least twelve days after injection.

In one series of experiments involving 120 mice, the dose of the organism was such that of the sixty untreated mice, fifty-six died and one was afflicted with arthritis. Of the sixty treated animals, only two died and four were afflicted with arthritis. The dosage of drug in this instance was 0.25 gm per kilogram of weight of the mouse. The amount of the gold preparation used appears to be rather large, but it was well tolerated by the mice.

In another set of experiments involving thirty mice, the amount of drug was reduced to 0.025 gm per kilogram of weight of the mouse. In this series thirteen of the fifteen untreated mice died, whereas of the fifteen treated mice, four died and six were afflicted with arthritis.

Four different strains of *Streptobacillus moniliformis* were used in these experiments. One of these strains was isolated from the blood of a patient who recently had rat-bite fever and the other three strains were isolated from rats. There was no noticeable difference in the therapeutic effectiveness of the gold compound on the infections experimentally produced by the use of these different strains.

The *in vitro* effect of the gold compound on the growth of the *Streptobacillus moniliformis* was found to be slight as compared with the *in vivo* activity of the compound. Twenty per cent. serum-veal infusion broth containing 0.125 per cent. of the gold compound caused a twenty-hour delay in the appearance of growth. When the broth contained 0.25 per cent., the final growth was decreased by one half. This drug caused some precipitation of the proteins of this medium, which may explain the effect on the growth of the microbe.

The organism was found to grow well in a medium consisting of soluble starch, proteose peptone and a number of salts. This medium contained much less protein than did the serum-veal broth and in this instance a concentration of the gold salt to 0.01 per cent. flocculated the medium and inhibited growth.

No therapeutic result was demonstrable with neoarsphenamine. In various experiments the drug was administered in amounts of 0.015 and of 0.03 gm per kilogram of weight of the mouse. It was administered by intravenous and by intra-abdominal injection, in some instances at the time of injection of the bacterial culture and in some instances six hours later.

Attempts to protect mice against experimental infection by the administration of sulfapyridine in the food were unsuccessful.[4, 5] Mice were placed on a diet of ground food mixed with 0.5 per cent. sulfapyridine for twelve, twenty-four and forty-eight hours before injection of the bacterial culture. In experi-

[1] Emmy Klieneberger, *Jour. Path. and Bact.*, 42: 587, 1936.

[2] Louis Dienes, *Jour. Infect. Dis.*, 65: 24, 1939.

[3] G. M. Findlay, R. D. Mackenzie, F. O. MacCallum and Emmy Klieneberger, *Lancet*, 2: 7, 1939.

[4] R. N. Bieter, W. P. Larson, E. M. Cranston and M. Levine, *Jour. Pharmacol. and Exper. Therap.*, 66: 3, 1939.

[5] J. Litchfield, White, H. and E. Marshall, *Jour. Pharmacol. and Exper. Therap.*, 66: 23, 1939.

ments involving fifty mice no favorable effect on mortality was observed in the treated group. In a small series of mice placed on a diet containing 1 per cent. sulfapyridine for forty-eight hours before injection, there appeared to be a prolongation of life by a few hours in the treated group over that of the control group. The final mortality, however, was not affected.

It appears that a single injection of gold sodium thiomalate (myochrysine) will protect mice against rapidly fatal doses of *Streptobacillus moniliformis*, whereas neoarsphenamine and sulfapyridine are ineffective against this organism.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PATTERNS ON MAPS AND DRAWINGS BY THE CARBON TRANSFER PROCESS

THE preparation for photolithographic reproduction of large numbers of isorithmic maps at the Muskingum Climatic Research Center[1] has led to the development of a simple and inexpensive process for shading them in distinctive patterns of black and white. It was necessary that the method be suitable for rapid use by workers having no experience in mechanical drafting or related techniques, that it cover large and small areas equally well and that the result be suitable for photomechanical reproduction. Hand ruling and stippling proved too difficult and too slow and failed to produce uniform results. Commercial pattern transfer methods were also slow and too expensive for the large total areas to be covered.

The new method, called the carbon transfer process, used successfully for the past year, is reminiscent of the simple childhood amusement of putting a paper over a coin and reproducing the pattern by rubbing with a pencil. In the new method, however, the marking is done by carbon paper and the back of the copy is rubbed with any hard smooth burnisher.

Maps or drawings to be patterned should be on thin paper or the areas should be outlined on the back by tracing or by the use of carbon paper so that they can readily be followed. To pattern the desired areas, place a sheet of wire cloth or other master pattern on a desk blotter spread on a smooth hard table top. Lay a sheet of moderately soft typewriting carbon paper on the master pattern, *face up,* and on this the drawing to be patterned, *face down.* A few lead weights will help keep this drawing and carbon paper in position on the pattern. To transfer the pattern, tool or burnish the back of the drawing smoothly but firmly in the areas where this particular design is desired. The bowl of a teaspoon, rounded back of a comb, bone-type hairpin, toothbrush handle or other smooth firm tool can be used, depending on the shape and size of the areas to be covered and on the coarseness of the pattern. Spraying the completed pattern with a suitable artist's "fixatif" will prevent smudging.

A large variety of patterns are available. Embossed book covers in grain or line patterns will serve for temporary use. More permanent are window screening and other types of wire cloth which are produced in hundreds of sizes and weaves. The usual square weave of sizes from 2×2 to 80×80 to the inch in various materials and wire sizes were tried. The coarsest and finest meshes were difficult to tool evenly, but those of intermediate size gave very satisfactory patterns. Weaves of unequal mesh, such as the 6×24, 14×88, "twilled," "flat warp," "double crimp," "rolled top" and many other kinds are available from the large manufacturers of wire cloth and give a variety of special effects. Some of these screens give two or more designs, depending on the tool selected and the direction of stroke. For uniformity of result it is generally more satisfactory to use a combination that gives the same pattern regardless of direction of tooling.

Patterns of a different type can be obtained from the molded plates used for making designs on mimeograph stencils. For line patterns, printer's brass rule can be set to the desired weight of line and spacing and locked in a form. Individual lines or pairs of lines can be tooled across the area to be shaded more rapidly than they can be drawn with a ruling pen and straight edge. Square or diamond patterns can be obtained by a second tooling with the lines crossing the drawing at a different angle.

Periods, colons, dotted leaders or other symbols in printer's type can be set to provide almost any weight and spacing of dotted patterns. Stereotype castings can be made from the type and preserved for permanent use. This work can be done by almost any newspaper office, and extra stereotype mats can be obtained so that additional plates can be cast later at small expense if those in use become worn.

Several of the patterns obtained by the carbon transfer process are shown in Fig. 1. Patterns A, B and C are produced from stereotype plates cast from periods. Pattern U is from mimeograph plate No. 1648. All other patterns in Fig. 1 are produced from

[1] Operated jointly at New Philadelphia, Ohio, by the U. S. Soil Conservation Service, the Works Projects Administration, the Muskingum Watershed Conservancy District and the National Youth Administration, in cooperation with the U. S. Weather Bureau and the Ohio Agricultural Experiment Station. C. W. Thornthwaite, SCIENCE, 86: 2222, 100–101, July 30, 1937.