showed many hundreds of colonies. A protocol of this type of experiment is shown in Table I. Other microorganisms were found to be similarly susceptible to the action of this aerosol. Among those tested were pathogenic invaders of the respiratory tract, *e.g.*, pneumococci Type I and III, hemolytic streptococci and hemolytic staphylococci, as well as organisms of lesser or no pathogenicity, such as *Streptococcus viridans, B. coli* and *Micrococcus catarrhalis.* Bacteria sprayed into a chamber containing the germicidal mist were killed with equal rapidity.

Tests made with other glycols showed that ethylene glycol and trimethylene glycol were about as effective germicidal aerosols as propylene glycol. Glycerine, on the other hand, exhibited only slight killing action.

To prove that condensation of the glycol itself, on the collecting plates, does not inhibit growth of the organisms by bacteriostasis, suitable controls were performed which definitely ruled out any such "plate effect." Furthermore, it is conceivable that the reaction between the germicidal aerosol particles and the bacteria might somehow change the state of suspension of the bacterial droplets and prevent their adherence to the plates. To control this possibility, another method was employed for collecting the bacteria after exposure to the aerosol: air was drawn slowly through 25–50 cc of diluted nutrient broth in a glass cylinder containing many small beads. Plated samples of this fluid, through which air from the control chamber had been bubbled, yielded large numbers of colonies, whereas similar samples of fluid exposed to the aerosol-containing air were sterile.

The presence of killed bacteria in aerosol-treated air was demonstrated by condensing on a chilled microscope slide the moisture of the air drawn from the chamber. The microorganisms were stained and identified; samples of the condensed fluid showed no growth.

We have also eliminated the possibility that microorganisms, although rendered incapable of growth on artificial media, might nevertheless retain the capacity to reproduce in a suitable host. Experiments were conducted in which virulent pneumococci Type I were treated in the chamber with the propylene glycol aerosol. The air was then drawn through sterile broth in a bead tower, and 1 cc quantities of this fluid injected into mice. These animals survived. However, when the experiment was performed with air drawn from the control chamber, all the mice died of pneumococcic infection.

The only criterion employed heretofore for the lethal action of aerosols has been failure of the exposed organisms to grow on agar-coated surfaces. We believe that the more rigid types of experimental controls described above should be employed as additional methods of evaluating the germicidal activity of aerosols.

The mechanism of the aerosol action, the physical properties of the germicidal mists, the time duration of their effective action,[9] minimum effective concentration, activity of other compounds, etc., are at present under investigation. We are also observing the effect on the lungs and other body organs of animals breathing aerosol-containing atmospheres for extended periods of time.

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RACEMIZATION OF GLUTAMIC ACID WITH ALKALIES

FISCHER, Kropp and Stahlschmitt[1] racemized 1(+)glutamic acid by heating it in barium hydroxide solution in an autoclave at 160–170° for 9 hours. We have found that a barium hydroxide solution of 1(+) glutamic acid becomes optically inactive in about 88 hours when it is heated in an ordinary bacteriological autoclave at 120°.

25 g of 1(+)glutamic acid and 105 g of $Ba(OH)_2 \cdot 8H_2O$ were mixed with 500 cc of water. This mixture was heated intermittently in the autoclave. At intervals samples were removed, cooled to room temperature and filtered. 15 cc of the clear filtrate were mixed with 4 cc of concentrated hydrochloric acid, and the resulting solution was read in the polarimeter. The results obtained are plotted in the accompanying figure.

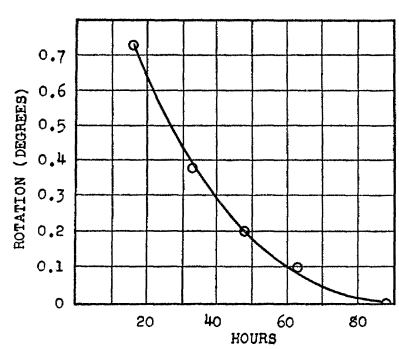

FIG. 1. Racemization of glutamic acid with barium hydroxide.

Town[2] mentioned using a sample of d,l-glutamic

[9] The germicidal action of the propylene glycol aerosol appears to be of brief duration. However, it has been found recently that the bactericidal effect may be prolonged for at least 90 minutes by the addition of a small quantity of glycerin.

[1] E. Fischer, W. Kropp and A. Stahlschmitt, *Ann. d. Chem.*, 365: 181, 1909.

[2] B. W. Town, *Nature*, 145: 312, 1940.

acid prepared by prolonged boiling of 1(+)glutamic acid in sodium hydroxide solution. We found that samples of 1(+)glutamic acid slowly racemized when they were boiled in 8 *N* and 4 *N* sodium hydroxide solutions. However, the yields obtained were very low. Ammonia was evolved continuously during the procedure, and it is evident that a considerable destruction of glutamic acid occurred.

It is our opinion that d,1-glutamic acid can be prepared most conveniently by racemization with heat.[3]

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COCHLEAR POTENTIALS FROM THE BAT

RECENT evidence[1, 2] indicates that bats locate objects in the space through which they are about to fly by hearing echoes of supersonic cries they emit. Normal flying bats produce supersonic cries having a duration of about 20 msec. in which frequencies near 50,000 cycles are most intense, and there is an increase in rate of emission as the animal approaches obstacles which will be successfully avoided. Bats rendered temporarily deaf and bats which are prevented from emitting the cry blunder into obstacles as if with no knowledge whatever of their existence.

These experiments can be explained only if it be assumed that bats hear sounds of 50 kc. In an attempt to test this assumption, cochlear potentials have been recorded from more than 30 bats of 5 different species with the results described below.

The bat cochlea produces electrical oscillations having the same frequency as the incident sound for frequencies up to 98,000 cycles. The 98 kc upper limit represents the limit of the recording apparatus, not of the cochlea. Appropriate checks establish the cochlea itself as the source of the potentials which appear in every respect to be similar to cochlear potentials from other mammals. The author, assisted by Mr. J. E. Hawkins, obtained no responses whatever above 40 kc from the cochlea of a young guinea pig tested in this apparatus.

The experiments were conducted in the laboratory of Dr. G. W. Pierce at Harvard, using a magnetostriction oscillator as the source of pure supersonic tones and a supersonic microvoltmeter to record potentials arising in the cochlea. Similar results can be obtained with a galton whistle or the cry of another bat as the source of supersonic sounds.

Although it is generally agreed that cochlear potentials per se do not necessarily indicate hearing, these experiments are taken to support the theory that bats locate obstacles by hearing echoes of their supersonic cries. Further details of the response of the bat ear will be presented in a report now in preparation.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

PHOTOELECTRIC TEMPERATURE CONTROL

A SYSTEM of control for a constant temperature bath employing a thyratron tube has been described by Schmitt and Schmitt.[1] The thyratron is a grid-controlled mercury vapor rectifier of considerable current carrying capacity. In their apparatus the tube served as an on-and-off relay, the grid potential being raised and lowered by the make-and-break of a toluene-mercury thermoregulator. Increased accuracy of temperature control, as compared with the usual electromagnetic relay system, was obtained as a result of the small current flow in the grid circuit and consequent avoidance of fouling of the mercury surface.

In the system which I shall describe, the advantages of the thyratron tube are more fully exploited by employing the phase-shift method of control and by eliminating the make-and-break contact altogether. The method makes possible the construction of a very accurate and reliable constant temperature bath at very modest cost.

A toluene-mercury thermoregulator is used which is so constructed that the column of mercury interrupts a beam of light concentrated to a point by means of a lens. This part of the apparatus is shown diagrammatically in Fig. 1. The light which passes through the capillary above the mercury strikes the cathode of a phototube. Rise or fall of the mercury

[3] L. E. Arnow and J. C. Opsahl, *Jour. Biol. Chem.*, 134: 649, 1940.

[1] D. R. Griffin and R. Galambos, paper read at the American Association for the Advancement of Science meetings in Philadelphia, Pa., January, 1941. Abstract in *Anat. Rec.*, 78: 95. 1940. Supplement.

[2] R. Galambos and D. R. Griffin, paper read at the American Association for the Advancement of Science meetings in Philadelphia, Pa., January, 1941. Abstract in *Anat. Rec.*, 78: 95. 1940. Supplement.

[1] F. O. Schmitt and O. H. A. Schmitt, SCIENCE, 73: 289, 1931.