NOTES.

Some Derivatives of p-*Aminobenzoic Acid.* By A. T. Fuller, C. R. Harington, Rosalind Pitt Rivers, and Joan M. L. Stephen.

Among derivatives of *p*-aminobenzoic acid which have been studied for their effect on bacterial growth, those in which the amino-group itself carries a basic substituent have hitherto escaped attention. Of the compounds whose synthesis is described below only one, namely 4-amino-4′-carboxydiphenylamine, shows significant antibacterial activity; this inhibits *Strep. hæmolyticus*, *Staph. aureus*, and *B. coli* in broth and synthetic media to about the same extent as sulphanilamide; in blood it is rapidly oxidised and is considerably less active. Testing of several of the compounds was limited by their insolubility. They showed no activity against acid-fast organisms, and none of them had more than a trace of anti-sulphonamide action.

N-*Acridyl*(5)-p-*aminobenzoic Acid.*—5-Chloroacridine (2·1 g.) was heated with phenol (10 g.) on the boiling water-bath for 15 minutes; anhydrous potassium carbonate (1·4 g.) and *p*-aminobenzoic acid (1·37 g.) were added and heating was continued for 14 hours. After cooling, the phenol was removed with ether and the residue taken up in hot 50% alcohol with addition of ammonia; on neutralisation with acetic acid the *acid* separated in glistening orange plates. Yield, 90%. M. p. 289—290° (decomp.) (Found: N, 9·0. $C_{20}H_{14}O_2N_2$ requires N, 8·9%).

N-8-*Chloro*-3-*methoxyacridyl*(5)-p-*aminobenzoic Acid.*—This *acid* was prepared as above, starting from 5 : 8-dichloro-3-methoxyacridine. Yield, 87% of scarlet prisms, m. p. 310—312° (decomp.) (Found: N, 7·2. $C_{21}H_{15}O_3N_2Cl$ requires N, 7·4%).

N-*Pyridyl*(4)-p-*aminobenzoic Acid.*—4-Chloropyridine (8 g.) and *p*-aminobenzoic acid (9·5 g.) in glacial acetic acid (28 c.c.) were boiled under reflux for 4 hours. The crystalline *hydrochloride* which separated on cooling was collected. It formed colourless needles, m. p. 264°. Yield, 60% (Found: N, 10·5. $C_{12}H_{10}O_2N_2$,HCl,H_2O requires N, 10·4%).

The free *pyridylaminobenzoic acid* crystallised in clusters of colourless needles when the aqueous solution of the hydrochloride was treated with 1 equiv. of sodium hydroxide. M. p. 318—320° (decomp.) (Found: N, 13·0. $C_{12}H_{10}O_2N_2$ requires N, 13·1%).

N-*Quinolyl*(4)-p-*aminobenzoic Acid.*—4-Chloroquinoline (9·0 g.) and *p*-aminobenzoic acid (7·5 g.) in acetic acid (25 c.c.) were boiled under reflux; after 2 minutes the contents of the flask solidified. Heating was continued for 1 hour on the water-bath, after which the mixture was cooled, ground with 50% aqueous acetic acid, and the solid collected. The product was dissolved in 50% alcohol with the aid of sodium hydroxide and neutralised at the boiling point with acetic acid. The *acid* crystallised in pale yellow needles, m. p. 314—316° (decomp.). Yield, 75% (Found: N, 10·5. $C_{16}H_{12}O_2N_2$ requires N, 10·6%).

N-*Quinolyl*(2)-p-*aminobenzoic Acid.*—This *acid* was obtained similarly (heating for 3 hours) from 2-chloroquinoline. Yield, 56% of pale yellow needles after recrystallisation from 50% dioxan. M. p. 285—286° (Found: N, 10·7%).

4-*Nitro*-4′-*carboxydiphenylamine.*—Dry sodium *p*-bromobenzoate (11·1 g.) was ground with anhydrous potassium carbonate (6·9 g.) and the mixture was added to a solution of *p*-nitroaniline (6·9 g.) in nitrobenzene (25 c.c.) containing activated copper (0·2 g.) and potassium iodide (0·2 g.) and heated to 130°. The temperature was raised to 190—210° at which level it was held for 24 hours. The nitrobenzene and unchanged nitroaniline (66% recovery) were removed by steam distillation and the solution filtered from tar and somewhat concentrated. On chilling, a sodium salt separated in red needles (yield, 46% allowing for the recovered nitroaniline) from which was obtained the free *acid*; this formed stumpy orange-brown needles from aqueous alcohol, m. p. 278° (Found: N, 11·2. $C_{13}H_{10}O_4N_2$ requires N, 10·9%).

4-*Amino*-4′-*carboxydiphenylamine.*—The sodium salt of the above nitro-acid (1·4 g.) was dissolved in aqueous ammonia and treated with hydrated ferrous sulphate (8·75 g.). After 10 minutes on the boiling water-bath the mixture was filtered; the precipitate of ferric hydroxide was extracted with boiling water and the combined filtrate and extract were acidified with acetic acid at the boiling point. After rapid filtration the solution was chilled in ice; the *acid* then separated in colourless prisms which darkened rapidly on exposure to air. It could be recrystallised from water or from xylene–ligroin. Yield, 77%. M. p. 205° (decomp.) (Found: N, 12·5. $C_{13}H_{12}O_2N_2$ requires N, 12·3%).—National Institute for Medical Research, Hampstead, N.W.3. [*Received, March 13th*, 1947.]

Rapid Preparation of a Solution of Sodium Hydrogen Sulphide.

By Herbert H. Hodgson and Edward R. Ward.

Previous work on this subject includes that of Stromeyer (*Annalen*, 1858, **107**, 333) who reported that carbon dioxide decomposed a solution of sodium sulphide, and that the latter evolved hydrogen sulphide when treated with sodium hydrogen carbonate, sodium carbonate being formed. No specific details are, however, available for the preparation of sodium hydrogen sulphide by reaction between equivalent amounts of sodium sulphide and sodium hydrogen carbonate, with subsequent use of alcohol to obtain the pure solution of hydrosulphide (cf. B.P. 184,795; U.S.P. 1,675,491). Earlier work by Hodgson and Birtwell on the reduction of 1 : 3-dinitronaphthalene (*J.*, 1944, 75; *J. Soc. Dyers Col.*, 1945, **61**, 171) revealed the necessity for the exclusion of sodium hydroxide and the prevention of a rise in the pH of the reduction medium for maximum reductive efficiency of sodium sulphide. Their reducing agent, however, was generally prepared warm and would lead to deterioration through loss of hydrogen sulphide. Later, Hodgson and Hathway (*J.*, 1945, 123) showed that sodium hydrogen carbonate could not be efficiently replaced by sodium carbonate in Hodgson and Birtwell's experiments, and that carbon dioxide was not evolved when an aqueous solution containing equivalent amounts of sodium hydrogen carbonate and sodium sulphide was heated. Finally, Hodgson and Ward (*J.*, 1945, 590, 663, 794) found that the reductive efficiency of the above mixture was superior to that of sodium hydrogen sulphide prepared by treating sodium hydroxide with hydrogen sulphide, or by the addition of hydrochloric acid to a solution of sodium sulphide (cf. Lapworth and Pearson, *J.*, 1921, **119**, 765; Lapworth and Haworth, *ibid.*, p. 768), in which much hydrogen sulphide is lost even by working in a tall cylinder at 0°.

A method is now described, whereby a comparatively concentrated solution of almost pure sodium hydrogen sulphide (96—98% of the calculated amount of NaSH) in aqueous methanol or ethanol can be rapidly prepared which contains only a negligible amount of sodium carbonate. Almost all the sodium carbonate formed by the reaction of the sodium sulphide and sodium hydrogen carbonate in aqueous methanol is precipitated as the crystalline monohydrate with a small amount of " occluded " sulphide. Other reagents such as boric acid, sodium hydrogen phosphate, oxalic acid, tartaric acid, and sodium hydrogen sulphate are unsuitable. Ethanol is nearly as efficient as methanol but acetone is unsuitable.

When an *aqueous* solution of sodium sulphide is treated with solid sodium hydrogen carbonate, precipitation of sodium carbonate decahydrate slowly takes place, but this is far from complete even after long standing at 15°.

Similar methods cannot be used to prepare pure aqueous alcoholic potassium hydrogen sulphide, owing to the much greater solubility of potassium carbonate in methanol or ethanol, and the alternative reactants above also proved unsuitable.

Experimental.—A concentrated aqueous solution of sodium sulphide is prepared by dissolution of the pure (" AnalaR ") nonahydrate ($\lessapprox$ 95% $Na_2S,9H_2O$) in freshly distilled water, and then diluted to contain 13% Na_2S w/v. Finely powdered sodium hydrogen carbonate (14 g.; 99·8% purity) is then stirred into the above solution (100 c.c.) below 20°; it dissolves at once with evolution of heat. Methyl alcohol (100 c.c.) is next added with stirring, also below 20°; there is further evolution of heat, and almost complete precipitation of crystalline sodium carbonate occurs immediately. After 30 minutes, the mixture is filtered at the pump, and the residue washed portionwise with methyl alcohol (50 c.c.). The filtrate now contains sodium hydrogen sulphide ($\lessapprox$ 9 g.) and a little sodium carbonate ($\gtrapprox$ 0·6 g.), the respective concentrations being *ca.* 3·5 g. and 0·2 g. per 100 c.c. of solution.

(*a*) For ordinary purposes, it is sufficient to dissolve equivalent amounts of sodium sulphide nonahydrate and sodium hydrogen carbonate in the required amount of water, add the necessary volume of methyl alcohol and filter off the precipitated sodium carbonate; the filtrate can then be used forthwith for reduction.

(*b*) When more concentrated solutions of sodium sulphide are employed, the precipitated sodium carbonate contains " occluded " sulphide.

(*c*) The solution of sodium hydrogen sulphide, which is only faintly alkaline to phenolphthalein, can be kept in a stoppered bottle for at least a week with but slight deterioration.

The authors are indebted to the Department of Scientific and Industrial Research for a Senior Research Award to one of them (E. R. W.), and to James Robinson and Co. Ltd., Huddersfield, for gifts of chemicals.—Technical College, Huddersfield. [*Received, April 9th,* 1947.]