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A NOTE ON AN EXPERIMENTAL PELLAGRALIKE CONDITION IN THE ALBINO RAT[1]

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The results of certain of the studies of pellagra prevention published early in 1925 (1) indicated that, while a protein of improved biological quality seemed to possess some favorably modifying effect, an additional, theretofore unrecognized or unappreciated, factor was needed completely to prevent the disease. There was reason to think, too, that this new factor, which for convenience was designated P–P, might be effective with but little, possibly without any, cooperation from the protein. The results of a still more recently reported study (2), which concerned itself mainly with fresh beef and a dried aqueous extract of yeast, seem to support that interpretation and to increase the probability that factor P–P plays the sole essential rôle in the prevention of pellagra. In the same report a preliminary statement was made of some of the results of an experimental study of the Chittenden-Underhill pellagralike syndrome in dogs (black tongue), and it was noted that the substances that had been found to possess black tongue-preventive potency had, when tried in pellagra, been found efficient preventives of the human disease, and, conversely, that the substances that had failed in pellagra, or were of low pellagra-preventive potency, when tried in black tongue had failed or were feeble as preventives of the canine disease. In view of this striking similarity it seems very probable and, therefore, the working hypothesis has been adopted, that black tongue of dogs is the analogue of pellagra in man and, thus, that factor P–P is the factor concerned in the prevention and causation of both pellagra and black tongue.

The evidence of the existence of a factor P–P resulting from the studies of the human and of the canine disease is confirmed or, at least, the existence of a closely associated factor indicated by evidence yielded by certain feeding experiments which we have carried out in rats.

Having found that dried yeast contains the factor that prevents the human and the canine disease, pellagra and black tongue, this substance was subjected to heat for 2½ hours in the autoclave at a

[1] Read in part at a meeting of the National Academy of Sciences, Washington, D. C., Apr. 27, 1926.

pressure of 15 pounds. In the dog, such yeast[2] prevents black tongue (2) but not polyneuritis (3). In the rat, as in the dog, it does not prevent polyneuritis nor does it permit this animal to grow, even when it forms as much as 40 per cent of a diet which is otherwise complete for growth except for the so-called water soluble B (2). From this it follows that the black-tongue-preventing factor was little if at all affected, while the antineuritic or beriberi factor was largely or completely inactivated by the treatment to which the yeast was subjected. Incidentally, it follows also that neither factor P–P nor any associated thermostable factor, if there be such, is, by itself, growth promoting in the rat.

Experience with the human disease and the results of experiments in the dog agree in indicating that Indian corn contains a fair supply of the antineuritic or beriberi factor, but relatively little if any of factor P–P (2). Accordingly, with a view of preparing a concentrated antineuritic preparation that should be relatively free from factor P–P, corn meal was extracted by percolation with 85 per cent (by volume) alcohol and the extract dried on cornstarch.

A suitable addition (6 per cent or more) of this preparation to the diet of rats presenting signs of polyneuritis has, in the case of animals with attacks not too far advanced, been followed by a clearing up of all evidence of polyneuritis. Healthy young rats fed diets, complete for growth[3] except for the so-called water soluble B, in which were included 6 per cent or more of this extract have, after some initial growth, shown an arrest followed sooner or later by a more or less rapid decline in weight. None has developed any signs of polyneuritis, but some have developed a pellagralike condition presently to be described. Clearly, then, our corn extract is potent not only in the cure but also in the prevention of polyneuritis or, in other words, it contains the antineuritic or beriberi factor. It may be noted, however, that it does not by itself (that is, when it is the sole source of the so-called water-soluble B) bring about sustained growth, even when forming as much as 71 per cent of the diet; yet when it is adequately supplemented with a known P–P containing substance, such as autoclaved yeast or a fullers'-earth preparation activated by treating with an aqueous extract of autoclaved yeast,[4] sustained

[2] Fleischmann's wort grown, low temperature dried yeast has been used in this study. For autoclaving, the yeast is put into Petri dishes 120 mm. by about 15 mm., and the dishes, uncovered, are arranged on a series of screen shelves in the autoclave.

[3] The basic composition of these diets is as follows: Purified casein, 20; Osborne and Mendel's salt mixture 4; cod liver oil, 2; crisco (a cottonseed oil preparation), 3; cornstarch, variable, to make 100.

[4] Ten pounds of yeast, autoclaved at 15 pounds for 2½ hours, is stirred into 25 liters of tepid water containing 2.5 cc. of glacial acetic acid and allowed to extract with repeated stirring for not less than 1½ hours. This is then passed through a Sharpless super centrifuge four times, discarding the insoluble matter. Into the resulting effluent there is stirred 750 grams of English fullers' earth that has been sifted through a 60-mesh sieve. This is kept agitated for about one hour and then the fullers' earth is separated by passing the suspension, first diluted with about an equal volume of distilled water, rapidly through the centrifuge. This earth, from which the soft puttylike portion is separated and discarded, is dried in a current of warm air, then ground to pass a 60-mesh sieve. Nitrogen content is about 1 per cent. This is our "P-P solid" which tests in the dog, still in progress, indicate possesses black tongue-preventive action in a daily dose of not more than approximately 2 grams per kilo of body weight.

growth results. This would clearly indicate that, as anticipated, the dried corn extract contains little if any of factor P–P or of an associated and likewise thermostable and fullers' earth adsorbable factor present in yeast and needed for growth in the rat. Incidentally, it may be pointed out that this also indicates quite clearly that for growth in the rat the diet must include both the thermolabile antineuritic [5] and a thermostable, fullers' earth adsorbable factor present in yeast, the latter of which is associated or, more probably, identical with the black tongue and pellagra-preventing factor P–P; and it therefore follows that substances reported in the literature as containing the so-called water-soluble B include both these factors in the same or different relative proportions.

Several years ago Seidell (4) devised a preparation of so-called vitamin B by adsorption from a yeast extract with English fullers' earth. This he designated "activated solid." [6] Tested by us on the dog this preparation has been found to contain the black tongue-preventing factor. In the rat, when fed at a 5 per cent or 6 per cent level as the sole source of "water soluble B," good growth to approximate adult size results. However, when the amount of this preparation as the sole source of "water soluble B" in the diet is reduced to between 0.5 and 1.0 per cent the growth of the rat is quickly arrested and the weight of the animal sooner or later begins to decline. In none of the animals so fed has any evidence of polyneuritis been observed, but a number have developed the same pellagralike condition as that exhibited by some of the animals on diets in which our dried corn extract was the sole source of so-called water soluble B. When there is included in the diets containing these low levels of "activated solid" as little as 9 per cent of autoclaved yeast or 6 per cent of a fullers' earth preparation activated by treating with an aqueous extract of autoclaved yeast, our "P–P solid," and known, by previous test, to contain the black-tongue-preventing factor P–P, growth is resumed with coincident improvement and, later, disappearance of the pellagralike condition.

From the foregoing it clearly appears that the limiting factor for growth in a diet in which the supply of "water soluble B" is derived entirely from 0.5 to 1.0 per cent of Seidell's "activated solid" is a thermostable, fullers' earth adsorbable factor associated or, more probably, identical with P–P. In this respect, then, such diet is essentially the same as the diet in which the sole source of supply

[5] It should perhaps be noted that, while autoclaving almost, if not quite, completely inactivates the antineuritic as it occurs in yeast, this treatment affects it little, if at all, as it occurs in Seidell's "activated solid" (unpublished data). The antineuritic, therefore, is not thermolabile under all conditions.

[6] In its preparation Seidell uses fresh brewers' yeast. We have modified his method by using the same yeast after drying. Of our dried brewers' yeast, 10 pounds are stirred into 25 liters of acidulated tap water, heated to 90° C, then brought to a boil. After partial cooling, the extract so prepared is treated exactly as described for "P–P solid" (see footnote 4). Nitrogen content is about 2 per cent.

of "water soluble B" is derived from our dried corn extract, that is, both types of diets, while containing sufficient antineuritic factor to more than prevent polyneuritis, are deficient in a thermostable, fullers' earth adsorbable factor associated or, more probably, identical with factor P–P present in yeast.

As has already been indicated, we have observed a corresponding similarity in the character of the pathological reaction exhibited by rats receiving these diets. In a study of such diets, still in progress, a number of the rats have developed a pellagralike condition to which we now wish to invite special attention.

After a variable period following the arrest of growth already mentioned, there has been observed in many of the animals so fed a tendency for the lids of one or both eyes to adhere together with, in some instances, an accumulation of dried secretion on the margins of the lids. At about the time or shortly after the appearance of this ophthalmia there has developed in nearly, if not quite, every one of the animals on the indicated diets, some loss of fur. This fur loss has in some begun in irregularly distributed patches. More commonly it has been observed to begin either at the side or over the top of the head, the sides or front of the neck, or in the region of the shoulders. From these initial sites the depilation has extended and in some of the animals has led to almost complete denudation of the head, neck, and trunk. The initially affected sites and, in the early stages, the areas involved by the spreading depilation have, in many of the animals, been sharply delimited and bilaterally symmetrical.

With or without such loss of fur some of the animals have developed a dermatitis at one or more of the following sites: Ears, front of neck and upper part of chest, forearms, backs of forepaws, shins, and the backs of the hind paws. This dermatitis, particularly as it has affected the paws, forearms, neck, and ears, has been sharply outlined and bilaterally symmetrical. To the eye it has differed somewhat with the site affected. The ears seemed definitely reddened and thickened with what appeared to be a yellowish incrustation of dried serum. In healing, desquamation took place, leaving the skin of the pinna with a polished, glistening, somewhat parchmentlike appearance. In one animal in which the dermatitis involved an extensive butterfly shaped area on the front of the neck and upper part of the chest, the affected skin was red and, at first, apparently superficially eroded and moist, then, like the ears, became dry, incrusted and rough. In the cases in which the backs of the forepaws were affected, the skin was red and rough and, after healing, but before the renewal of the normal fine, silky fur, the skin had a pale pink, glistening, new-skin appearance. The backs of the hind paws, when affected, presented at first an appearance as of a matting of the silky fur of this part, which then looked dull and thickened. Later this matted

layer of fur began to fissure and to crack and then gradually desquamated, leaving a denuded pale pink, glistening skin. The shortest period so far recorded within which this dermatitis has appeared has been approximately seven weeks. In a few of the cases so far observed, the affected animals have presented a linear fissuring or ulceration at the angles of the mouth. In a somewhat larger number there has occurred a lesion at the tip of the tongue, which first appeared as a small, roughly circular, grayish opacity or bleb, or as an ulceration which, in some, went on to the formation of a localized yellowish slough. In one of such animals there was evidence also of an inflammation of the anterior part of the floor of the mouth. In two, diarrhea was present. As has already been mentioned, the inclusion in the diet of such animal of as little as 6 per cent of our "P–P solid" is followed (if the animal is still able to eat) by a clearing up of the evidence of this condition, with resumption of growth.

The appearance presented by some of the animals suffering from this experimental condition forcibly recalls certain commonly met with types of human pellagra. The identity suggested by this clinical similarity is supported, as has been explained, by the apparent identity of the dietary deficiency associated with the development of the respective conditions.

Although the facts briefly reviewed in the foregoing make it very probable that the thermostable, fullers' earth adsorbable dietary factor that seems to be related to the pellagralike condition in the rat is the same as that needed (in combination with the antineuritic) for growth in the rat and likewise the same as that related to black tongue and pellagra, the possibility, remote though it seems, is not excluded that there may be in yeast more than one such thermostable factor which further study may succeed in differentiating. Moreover, it is not clear that all essential factors, or necessary relations among such factors, for the nutrition of the albino rat have as yet been determined. The possibility is therefore also present that the diets with which we are at present concerned may have been deficient or faulty in some respect not recognizable in the present state of knowledge, to which the experimental condition in the rat, distinguished by the pellagralike dermatitis, may in part or in whole be related and which is corrected by such preparation as our "P-P solid". We may conclude, therefore, that while it is, on the whole, highly probable that the pellagralike condition in the rat is the analogue of pellagra in man, it will require additional evidence to establish this beyond reasonable doubt.

REFERENCES

(1) Goldberger and Tanner: Pub. Health Rep., Wash., D. C., 1925 (40): 54–80.
(2) Goldberger, Wheeler, Lillie, and Rogers: Pub. Health Rep., Wash., D. C., 1926 (41): 297–318.
(3) Unpublished data.
(4) Seidell: Pub. Health Rep., Wash., D. C., 1922 (37): 801.

A DISTINCTIVE TEST FOR CYSTEINE

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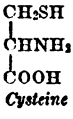
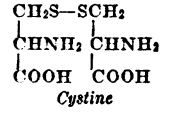
Cysteine and cystine are closely related amino acids containing sulfur. They have been found to play a very important rôle in nutrition, in the inner metabolism of the body, in cellular respiration, oxidation and reduction, and in biochemical defense. The development of these various phases of the rôle of cysteine and cystine as such or in combination with other compounds is beyond the scope of this paper, which will deal with a new test. This test has the distinction of being the first highly specific colorimetric test for cysteine. Because of the importance of cysteine as stated above, the test should be useful in many fields of research.

As established by Friedmann (1903), the structural formulas of cysteine and cystine are—



Cysteine



Cystine

Cysteine is readily oxidized to cystine, while the latter, on reduction, goes to cysteine.

There is no direct chemical test for cystine. Its estimation has depended on actual isolation of the substance, generally from hydrolysates, or upon nonspecific color reactions. Cystine when boiled with aqueous alkali yields an alkaline sulphide which can be detected as PbS. Stadthagen (1885) and Goldmann and Baumann (1888) employed this method for the determination of cystine in urine, with contradictory results. At the best this test is not satisfactory since, when positive, it is not necessarily indicative of cystine inasmuch as cysteine and glutathione likewise give PbS when heated with alkali and lead acetate. Recently Folin and Looney (1922) developed a colorimetric method for the determination of cystine in protein hydrolysates which depends on the reduction of cystine to cysteine by sodium sulphite and estimation of the cysteine by the uric acid reagent. Looney (1922) employed this colorimetric method for the quantitative determination of cystine in urine. This colorimetric method is not specific for cystine, since we have found that in nonhydrolyzed solution the same color reaction is given more or less by other disulphides, such as oxidized glutathione. With it, too, it would be rather difficult to differentiate between cystine, cysteine, and glutathione, especially in the presence of uric acid.

Of the tests which have been employed for the detection of cysteine, the most delicate is the nitroprusside reaction introduced by Mörner (1899). Denigès (1889) had found the violet color produced by sodium nitroprusside ($Na_2Fe(NO)(CN)_5+2H_2O$) and alkali a very

delicate test for the sulphydryl group of mercaptans, and Mörner (1902), applying it to cysteine, claimed that it would detect one part of cysteine in 50,000 parts of water.

The wide occurrence in living tissue of substances giving the nitroprusside reaction is illustrated by the investigations of Gola (1903), on plants, and of Buffa (1904), Heffter (1908), and Arnold (1910), on animal tissue. Heffter, perhaps, did more than any other of the earlier investigators to emphasize the importance of the nitroprusside reaction by his comments upon the possible significance of the sulphydryl group which the test is supposed to reveal.

Recently, Hopkins (1921), employing the nitroprusside reaction step by step in his procedure, succeeded in extracting from yeast, mammalian muscle, and mammalian liver, a dipeptide of cysteine and glutamic acid, to which he gave the name glutathione and the empirical formula $C_8H_{13}N_2O_5SH$. By his isolation of glutathione, Hopkins gave definiteness to the whole subject of the relation of the SH group to cellular oxidation-reduction and made a reality of what had long been a probability, namely, the presence of a definite SH compound in tissues. Later, Quastel, Stewart, and Tunnicliffe (1923) showed that the constitution of glutathione is

$$\begin{array}{l} CH_2SH \\ | \\ CHNH\text{-}CO\text{-}CH_2CH_2CHNH_2COOH \\ | \\ COOH \end{array}$$

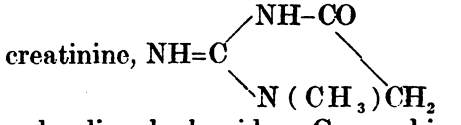
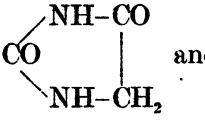
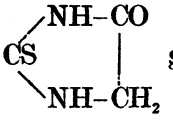
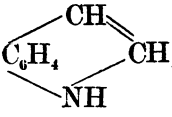
As pointed out by Dixon and Quastel (1923), reduced glutathione and cysteine have many features in common, and the differences are such as not to indicate any essential dissimilarity between the chemical behavior of the two compounds. The oxidized forms, however, differ in solubility. Oxidized glutathione is quite soluble in water even without the addition of acid or alkali, whereas cystine is soluble only in distinctly acid or alkaline solution.

Hopkins concluded that glutathione is the substance responsible for the nitroprusside reaction which is given by nearly all animal tissues and that it contains "practically all of the non-protein organically bound sulphur of the cell." It is apparently the most important autoxidizable constituent of the cells.

Using the same nitroprusside reaction, Abderhalden and Wertheimer (1923) could not agree with Hopkins's view that glutathione is the sole substance in tissue which gives the nitroprusside reaction. They consider that there must be in tissue either cysteine as such or cysteine bound in other ways than as glutathione.

Tunnicliffe (1925) supports Hopkins's view and considers that the whole of the soluble sulphydryl groups in the tissues are those of glutathione, and further that there is no evidence that cysteine exists, as such, free in normal tissue.

THE NITROPRUSSIDE TEST FOR CYSTEINE

In most of the work on the presence of a sulphydryl group (SH) in tissue and tissue extracts the test has been the violet red color with sodium nitroprusside and alkali. Leaving aside for the moment the reliability of this test for normal tissue, it may be said that the nitroprusside reaction is not specific for cysteine or reduced glutathione or even for the sulphydryl group. Playfair (1849), who first made sodium nitroprusside, found that it gave a beautiful purple color with soluble sulphides and, in fact, was a very delicate test for them. Weyl (1878) found that creatinine, 
gives a ruby red with nitroprusside and sodium hydroxide. Guareschi (1887) reported that hydantoin,  and thiohydantoin,  give a rose to violet color. Legal (1883) and le Nobel (1883) found that acetone gives a violet red with nitroprusside and alkali. Nickel (1890) obtained the nitroprusside reaction with acetaldehyde, isobutylaldehyde, and oenanthaldehyde. Von Bitto (1891) found that various aldehydes and ketones gave color ranging from yellow-red to violet with nitroprusside and alkali and that indol,  , even in extreme dilution, gives a red-violet color with nitroprusside and alkali.

The alkali referred to in the preceding section is sodium hydroxide. The best practice in the nitroprusside test for cysteine or reduced glutathione calls for the use of a saturated solution of ammonium sulphate followed by the nitroprusside and excess of ammonium hydroxide as used by Hopkins (1921) in his application to glutathione of the Rothera (1908) test for acetone. With ammonium hydroxide, as compared with sodium hydroxide, fewer compounds give red to violet color with nitroprusside. Thus creatinine gives no red with nitroprusside and ammonium hydroxide. However, using NH_4OH we have obtained colors approximating the color given by dilute solutions (100 p. p. m.) of cysteine or reduced glutathione by compounds such as acetone, ethyl aceto-acetic acid, cyanacetamide, and other compounds free from sulphur; and we are convinced that a positive reaction with sodium nitroprusside must be judicially

considered before decision as to the presence of a sulphydryl group can be made.

Fortunately, however, normal tissue apparently contains little if any of the interfering substances so that with the tissues of the body and normal excreta the occurrence of a violet-red color on addition of sodium nitroprusside and ammonium hydroxide is indicative of the presence of the sulphydryl group and presumptively indicates the presence of cysteine or reduced glutathione, but does not distinguish between them.

As to the presence of free cysteine and cystine in tissue and excreta, aside from the tissues and urine in cystinuria, in which case free cystine has actually been isolated, the question, we believe, is still open. Looney (1922) gives a colorimetric method for the quantitative determination of cystine in urine. This colorimetric method, however, we have found would likewise estimate other disulphides such as oxidized glutathione.

The need of a more specific test for cystine and cysteine is apparent, not only for the determination of these substances in normal tissues and excreta and for the investigation of their role in metabolism, but also in various metabolic abnormalities in particular in the systematic investigation of cystinuria.

An absolutely specific reaction for any amino acid may be impossible. Be that as it may, the fact is that in the behavior of cysteine with 1.2 naphthoquinone-4-sodium sulphonate we have a reaction for cysteine that affords at least a high degree of specificity.

GENESIS OF THE NEW CYSTEINE REACTION

The great capacity of 1.2 naphthoquinone-4-sodium sulphonate, also called sodium beta-naphthoquinone-4-sulphonate, to react with other compounds with the production of complexes of high tinctorial power was early recognized by Witt and Kaufmann (1891), who first made the compound, and by Böniger (1894), who gave a number of its reactions of the oxy-indophenol type.

Ehrlich and Herter (1904), and especially Herter (1905), greatly extended the number of color reactions obtainable with 1.2 naphthoquinone monosodium sulphonate and indicated many biological applications of the reaction. Ehrlich and Herter found that the naphthoquinone in question would give a precipitate with aniline in the concentration of 1 part of aniline in 300,000 parts of solution and a good red color in the dilution of 1 in 1,000,000. Among the reactions mentioned by Ehrlich and Herter, and especially by Herter, the reaction with amines and amino acids seemed to be worthy of further study.

As stated by Herter, amino acids react readily with the naphthoquinone and give a red color or some shade of brown. Herter recognized the biochemical value of these reactions and suggested

that the color reactions of the amino acids with the naphthoquinone sodium monosulphonate might make possible the following of amino acids (at least as a group) in their origin from protein in the intestine and during their absorption and further distribution.

Folin (1922) gave in detail a method for the preparation of 1.2 naphthoquinone-4-sodium sulphonate and employed the compound in his new colorimetric method for the determination of the amino acid nitrogen in blood. For his work Folin found it necessary to have the quinone perfectly pure and gives precise directions for purifying and standardizing the compound.

The 1.2 naphthoquinone-4-sodium sulphonate used by us was of two sources—(1) commercial, (2) that made in the Hygienic Laboratory. The commercial sample had to be purified before it was satisfactory in quantitative colorimetric work. The easiest method of purifying the compound is that given by Folin. The second sample was made and purified by Dr. Alice T. Merrill, who followed Folin's published directions.

Folin gave as useful tests for the purity of 1-2-4 naphthoquinone-sulphonic acid—

(1) *Color.*—The color of a fresh 1 per cent solution of the quinone in water will read 26 to 27 mm. when compared with a 0.5 N solution of potassium bichromate set at 20 mm. in the Duboscq colorimeter.

(2) *Colored decomposition products.*—Two c. c. of the fresh 1 per cent quinone diluted to 25 c. c. in a test tube and treated with 1 c. c. of a 50 per cent acetic acid and then with 1 c. c. of 15 per cent sodium thiosulphate solution should bleach in a few seconds so completely that it is only by looking through the length of the tube that a faint yellow shade is visible.

(3) *Ammonia.*—No ammonia should be present in the quinone.

In our work we have found further that a satisfactory sample of 1.2 naphthoquinone-4-sodium sulphonate gives only a pale yellow color when 2 c. c. of a 1 per cent solution are treated with 5 c. c. of 10 per cent anhydrous sodium sulphite in 0.5 N NaOH.

Our primary interest in the reaction between 1.2 naphthoquinone-4-sodium sulphonate and various compounds mentioned by Herter, such as indole, amines, and amino acids, lay in the possibility that the colored compounds thereby formed would act as oxidation-reduction indicators. It was found, in fact, that the colored compounds thus formed could be reduced to yellow by sodium hyposulphite and that the yellow on shaking in the air returned more or less to the original color. However, in testing the reaction of various compounds with 1.2 naphthoquinone-4-sodium sulphonate in the presence of sodium hydroxide an interesting and apparently distinctive test for cysteine was obtained. Two variations of the test were devised,

designated here as (1) the alkali-sodium hyposulphite modification, (2) the sodium sulphite modification.

GENERAL OUTLINE OF THE TEST AND DISCUSSION OF ITS SPECIFICITY

In the hyposulphite process, for solutions containing from 50 to 400 parts per million of cysteine, 1 c. c. of a 0.5 per cent solution of the naphthoquinone is added to 5 c. c. of the solution to be tested followed by 5 c. c. of NaOH (from 0.25 N to 2 N NaOH), and after a lapse of ten minutes by 1 c. c. or 2 c. c. of a 2 per cent freshly-prepared solution of sodium hyposulphite ($Na_2S_2O_4$) in 0.5 N NaOH. Many compounds give a color with the quinone and alkali.

On addition of the hyposulphite, however, practically all the compounds tested, as shown in Tables 1 and 2, were discharged to yellow, while cysteine solutions changed from brown red to a vivid red. As shown in Table 1, compounds that might be associated with cysteine in metabolism or excretion give only a yellow color.

Certain compounds, such as pyrogallol, phloroglucinol, and pyrrol, and, to a slight degree, hydroquinone, tend to interfere in the sodium hydroxide-hyposulphite process. As will be shown later, their interference can be excluded.

Considering that the ten minutes contact of approximately 0.25 N or 0.5 N NaOH with cysteine and the naphthoquinone had the drawbacks that some cysteine might be oxidized by the alkali in presence of air and, secondly, that the naphthoquinone itself gave a brown color, other combinations were tried, especially combinations where the alkali and reducing agent were added at the one time. A solution of sodium hyposulphite ($Na_2S_2O_4$) in alkali gave only a yellow color with cysteine; a solution of sodium thiosulphate in alkali gave color with all the amino acids tried. A solution of anhydrous sodium sulphite in alkali, however, was found satisfactory in that it gave a red brown color with cysteine and only a yellow color with other amino acids tried. This alkali-sodium sulphite mixture was found also to give a greater amount of color than the NaOH followed by hyposulphite. Accordingly it was utilized in the sodium sulphite process now to be given in greater detail.

In the sodium sulphite process there is added to 5 c. c. of the solution under test (containing not more than 400 parts per million of cysteine) 1 c. c. of a 0.5 per cent solution of the naphthoquinone and 5 c. c. of a 10 to 20 per cent solution of anhydrous sodium sulphite (Na_2SO_3) in 0.5 N or 0.25 N NaOH. As a rule, within 10 minutes after the addition of Na_2SO_3, 1 c. c. of an aqueous 5 per cent solution of NaCN (96 per cent. purity) is added. The cyanide is not absolutely necessary, but is added to help check the tendency of cysteine to oxidize and to stabilize the red color formed in the process. After ten minutes, reckoning from the addition of Na_2SO_3,

1 c. c. of a 2 per cent solution of sodium hyposulphite in 0.5 N NaOH is added. This reducing agent converts the reddish brown color given by cysteine to a purer red apparently by decolorizing the excess of the naphthoquinone. As shown in Tables 1 and 2 all other compounds tested, with the exception of pyrrol, pyrogallol, hydroquinone, and phloroglucinol, give only a yellow or slight orange color, especially on addition of the hyposulphite. The compounds mentioned give colors more resistant to reduction by hyposulphite. Cystine if present in high concentration may slowly give a red color, due to reduction to cysteine; but in concentration of 400 parts per million the color given by cystine is practically negligible within 25 minutes after addition of the alkaline sulphite.

In Table 1, wherein are listed compounds more closely related to cysteine by chemical composition or by association in protein digestion or in excreta, not one substance interferes with the cysteine reaction in either process—that is, all excepting cysteine are discharged to yellow by the reducing action of Na_2SO_3 and especially by $Na_2S_2O_4$.

In Table 1 are listed most of the amino acids obtainable from protein. Arginine, isoleucine, and oxyprolin were not available. To get some idea of the reaction of these three amino acids, recourse was had to protein hydrolysates known to contain these acids among others. Thus ninety grams of the phosphotungstic precipitate of hydrolyzed lactalbumin, were obtained from Dr. D. Breese Jones of the Protein Investigation Laboratory, Bureau of Chemistry, United States Department of Agriculture. These ninety grams, it is calculated, contain at least 1 gram of arginine. They were freed from phosphotungstic acid by means of $Ba(OH)_2$. The filtrate, freed from Ba by means of H_2SO_4, was brought to pH 3 and was then concentrated to 40 c. c. When 5 c. c. of this concentrate, which contained approximately 1 per cent of nitrogen, were tested by means of the cysteine reaction, the result was a pale yellow color—that is, the cysteine reaction was negative.[1] The unfractionated products obtained by hydrolyzing casein and gelatine likewise gave a negative reaction.[1] Thus fifty grams of casein and of gelatine, respectively, were hydrolyzed forty hours with boiling concentrated HCl. The hydrolysates were filtered, concentrated under reduced pressure, brought to pH 3 with NaOH, filtered, concentrated to 400 c. c., decolorized by norite, and filtered. The slightly brownish yellow filtrates were diluted to 400 c. c. with H_2O. Five c. c. of the filtrate tested by means of the cysteine reaction, alkali hyposulphite, and sodium sulphite procedures, gave yellow or colorless solutions on adding $Na_2S_2O_4$. In the case of the casein there was also a colorless

[1] By a modification of the reaction, described later, cystine was found in the hydrolysates of lactalbumin and of casein.

precipitate, and in case of both gelatine and casein in the sodium sulphite procedure there was a blue color before adding the hyposulphite. From the evidence at hand, however, we feel safe in saying that none of the amino acids obtained by decomposing the protein molecule will interfere with the cysteine reaction.

In Table 2 are listed various compounds tested (1) because, like pyruvic acid, they may arise as decomposition products of cysteine and cystine and other compounds; (2) because they are used therapeutically; (3) because they may occur in plant or animal tissue in small amounts; or (4) because they have been mentioned in the literature (Herter 1905) as reacting in some way with 1.2 naphthoquinone-4-sodium sulphonate.

Of the compounds listed in Table 2, pyrogallol, phloroglucinol, pyrrol, and, to a less degree, hydroquinone, interfere more or less with the cysteine reaction, especially in the alkali-hyposulphite procedure. Pyrogallol gives with the naphthoquinone and alkali a brown red color which is only slowly discharged by addition of $Na_2S_2O_4$. Hydroquinone gives a red brown which is generally discharged to yellow, but may be changed to an interfering brown yellow. Phloroglucinol remains a decided red on addition of 1 c. c. of 2 per cent $Na_2S_2O_4$ in 0.5 N NaOH. Pyrrol gives a dark green color with the naphthoquinone—a color which persists with the addition of alkali and alkaline sulphite and changes to a brown or amber on addition of sodium hyposulphite. These compounds would interfere with the cysteine reaction, especially in the alkali-hyposulphite procedure.

In the sodium sulphite procedure, however, phloroglucinol becomes pale yellow, pyrogallol a yellow red, and hydroquinone a faint rose; and these colors fade out readily. Though the occurrence of these compounds in association with cysteine in normal tissue, tissue extracts, or hydrolysates, in amounts sufficient to interfere with the cysteine reaction, is highly improbable, yet we included them in our study because (1) they tend to give colors with alkali and (2) we desired to include in our work all substances which might interfere in our reaction—and samples of which were available. It became of interest to find out whether such types of compounds could be readily excluded from interfering. It was found in fact that the exclusion of interference by pyrogallol, hydroquinone, phloroglucinol, and pyrrol, all of which had been found by us somewhat troublesome, could be readily brought about. Thus, if to 5 c. c. of the hydroquinone and pyrogallol solutions, respectively, in 0.1 N HCl, 1 c. c. of a 1 per cent solution of NaCN be added, the solutions mixed by shaking and allowed to stand 5 to 10 minutes, the addition of the naphthoquinone followed by NaOH (0.25 N or 0.5 N) gives only a slight red which is changed to a slight orange by sodium hyposulphite, and in the sodium sulphite process to a yellow orange, while cysteine

similarly treated gives a vivid red. Cystine similarly treated gives only a faint and negligible red. Pyrrol treated with 1 c. c. of 1 per cent NaCN gives a blue green with the naphthoquinone and alkali or alkaline sulphite; but this color is converted to yellow by sodium hyposulphite. Pyrrol treated with 1 c. c. of a 5 per cent aqueous solution of NaCN, mixed and treated at once with the naphthoquinone, remains yellow. Then treated with alkali it becomes a blue green which is converted to yellow by $Na_2S_2O_4$. Pyrrol treated with 1 c. c. of 5 per cent NaCN gives only a yellow with the naphthoquinone and 10 per cent sodium sulphite in 0.25 N or 0.5 N NaOH.

Phloroglucinol treated with 1 c. c. of 1 per cent NaCN and after 10 minutes with the naphthoquinone and alkali gives a red brown which is changed to red by $Na_2S_2O_4$—a red which fades slowly to yellow. Phloroglucinol treated with NaCN gives only a pale yellow with the naphthoquinone, followed by 10 per cent Na_2SO_3 in 0.25 N. or 0.5 N NaOH.

Cysteine treated with 1 c. c. of 5 per cent sodium cyanide and immediately with the naphthoquinone and alkali or alkaline sulphite gives a strong brown red which is made more vividly red by sodium hyposulphite—cystine similarly treated gives a negligible faint reddish color within twenty minutes after adding the reagents.

All in all, the tables show that, in so far as compounds have been tested, the cysteine reaction with 1.2 naphthoquinone-4-sodium sulphonate and alkali and reducing agents such as sodium sulphite and sodium hyposulphite has a remarkable and quite unexpected degree of specificity. With the use of NaCN to keep out interference by pyrogallol, phloroglucinol, and pyrrol, the specificity in the sodium sulphite procedure has so far been absolute.

In both modifications of the cysteine reaction we have used 1 c. c. of the naphthoquinone up to 400 parts per million of cysteine, 2 c.c. up to 1,000 parts per million. Most of our work has been done at the 400 parts per million level, since above this the color produced is too intense for satisfactory colorimetric work. Other proportions of the naphthoquinone were tried, 2, 3, 4 to 6 c. c., but the 1 c. c. was found most suitable.

In the sodium sulphite process, the use of 10 per cent Na_2SO_3 in 0.5 N NaOH was decided to be the best concentration for all around purposes. We have found, in fact, that much smaller quantities of sodium sulphite will suffice to develop the red color where cysteine is present—and a yellow only with other amino acids, for example, tyrosine. The precise limits of alkalinity and of sodium sulphite we are now working on. However, as indicated, we have found that 10 per cent sodium sulphite in 0.5 N NaOH is satisfactory over a long list of substances. The work obtained in this paper is given primarily as an example of the use of the cysteine reaction with the

realization that, in minor details at least, it probably can be improved upon.

As the reaction is a cysteine test it can be used for the estimation of substances which yield cysteine by reduction, by hydrolysis, or by a combination of these processes, for example, cystine and glutathione. The particular details of the reaction in a comparison, qualitatively and quantitatively, of the behavior of cysteine and of other amino acids and thio compounds are given in the following pages.

APPLICATION OF THE TEST TO CYSTEINE AND OTHER AMINO ACIDS (HYPOSULPHITE MODIFICATION)

Solutions in 0.1 N HCl of various amino acids, such as tyrosine, glutamic acid, histidine, aspartic acid, dl alanine, phenylalanine, glycocoll, tryptophane, leucine, cystine, creatinine, and cysteine hydrochloride were made so that each c. c. contained approximately 0.05 of a milligram of nitrogen. To 5 c. c. of each solution was added 1.0 c. c. of a 0.5 per cent solution of 1.2 naphthoquinone-4-sodium sulphonate, and 5 c. c. 0.5 N NaOH. Colors varying from reddish orange to deep brown developed. After standing 10 minutes each tube was treated with 1 c. c. of a freshly prepared 2 per cent solution of sodium hyposulphite $Na_2S_2O_4$ in 0.5 N NaOH. The color was discharged in every tube excepting that containing cysteine, which became a brighter red. Ammonia as 1 per cent NH_4OH in the presence of 1.2 naphthoquinone gives a green-brown but this green-brown is converted to light yellow by addition of 1 c. c. of 2 per cent solution of sodium hyposulphite $Na_2S_2O_4$.

Since cystine, the oxidized form, does not give the reaction given by cysteine, as just described, it seemed probable, *a priori*, that the sulphydryl group (SH), which is known to be highly reactive, would explain the difference between the reaction of cysteine with 1.2 naphthoquinone-4-sodium sulphonate and the reaction of other amino acids. Accordingly, various sulphur and sulphydryl compounds were tested in a similar way.

NONINTERFERENCE OF OTHER SULPHUR AND SULPHYDRYL COMPOUNDS

Among the sulphur and sulphydryl compounds employed were hydrogen sulphide (H_2S); thiourea ($CS(NH_2)_2$); thioacetic acid (CH_3COSH); monothiosalicylic acid ($C_6H_4SHCOOH$); thiobarbituric acid ($CS(NHCO)_2CH_2$); thioglycollic acid ($CH_2SHCOOH$); thiolactic acid ($CH_3CHSHCOOH$); thiophenol (C_6H_5SH); thiocresol ($CH_3C_6H_4SH$); thiobetanaphthol ($C_{10}H_7SH$); and glutathione, reduced form ($C_8H_{13}N_2O_5SH$), oxidized form ($C_{16}H_{26}N_4O_{10}S_2$). The

various sulphur and sulphydryl compounds (used in concentration from 500–1,000 parts per million when soluble and as saturated solution when not soluble to this extent) reacted with 1.2 naphthoquinone-4-sodium sulphonate in alkaline solution, 0.25 N NaOH to 2.5 N NaOH, with the formation of orange or brown colors which were discharged to pale greenish yellow by addition of sodium hyposulphite ($Na_2S_2O_4$). On three or four hours contact with the reagents, glutathione may give a slight red color. Within 30 minutes, however, it gives only yellow in presence of sodium hyposulphite.

To summarize, it should be stated that of the various amino and sulphur and sulphydryl compounds tested, cysteine is the only compound which gives a color with 1.2 naphthoquinone and alkali which persists in the presence of sodium hyposulphite.

As shown in experiments 1, 2, and 3, the NaOH–$Na_2S_2O_4$ method will determine cysteine quantitatively in a mixture of amino acids such as glycocoll, tyrosine, glutamic acid, and cystine.

The color given by cysteine becomes a beautiful red on addition of the sodium hyposulphite. Solutions containing 50 parts per million cysteine HCl (38.5 parts per million cysteine) still give a red color. The reaction apparently required a high pH. As we have been carrying out the reaction the mixture was alkaline to the degree of an 0.1 N to 1 N NaOH.

In a few experiments wherein to 5 c. c. of an aqueous solution of cysteine HCl, the naphthoquinone and 5 c. c. of buffer 11.7 were added, the cysteine reaction was negative, that is, the red color which developed was decolorized by addition of sodium hyposulphite. If, however, the alkalinity of the red buffered solution was raised by addition of strong NaOH (10 per cent) before addition of sodium hyposulphite, the red color was not discharged.

The red color is changed to yellow by acids. The yellow acid solution becomes red again on adding alkali.

SODIUM SULPHITE MODIFICATION

When 5 c. c. of separate solutions of various amino-acids containing approximately 0.05 mg. of nitrogen per c. c. or solutions of various thio-compounds (500 parts per million) are treated with 1 c. c. of a 0.5 per cent solution of 1.2 naphthoquinone-4-sodium sulphonate and then with 5 c. c. of a 20 per cent solution of anhydrous sodium sulphite in 0.25 N NaOH, the cysteine gives a reddish color which begins to form at once. Aside from cystine, no other amino acids or thio compound gives the red color in the presence of sodium sulphite. Cystine solutions slowly give a slight red color due to a slow reduction of cystine to cysteine by the sulphite. Within 25 minutes, however, the color given by cystine in concentration of 400 parts per million and less is practically negligible. Ammonia, if

present as a 1 per cent NH_4OH solution, may interfere with the estimation of cysteine by giving a greenish-brown color. The further addition of 1 c. c. of 2 per cent solution of $Na_2S_2O_4$ in 0.25 N NaOH converts the greenish-brown shade of the NH_4OH to light yellow, which does not interfere with the cysteine color, which becomes a purer red.

The red color given by cysteine tends to fade slowly; but if in addition to the reagents mentioned, 1 c. c. of a 5 per cent aqueous solution of sodium cyanide is added, the red color developed in the presence of cysteine is made stable over a long period—several hours at least.

With the sodium sulphite process, the color given by cysteine varies from a deep garnet for solutions containing 400 parts per million of cysteine hydrochloride (307 parts per million of cysteine) to slight red for 50 parts per million of cysteine HCl, and orange red for 25 parts per million cysteine HCl (20 p. p. m. cysteine) and distinct orange for 10 parts per million cysteine.

If the 1.2 naphthoquinone-4-sodium sulphonate is pure and the solution is used shortly after being made, it gives by itself only a faint yellow color with alkali and reducing agents such as sodium sulphite and sodium hyposulphite. Otherwise it should be purified by Folin's (1922, page 389) procedure. Several times in our experimentation, however, even with the supposedly purified quinone, a slight rose color was given by the reagents in the Na_2SO_3 process. This color, due undoubtedly to local impurity, was negligible in comparison with the color produced by cysteine in concentration of 77 parts per million in tenth normal hydrochloric acid. Further, the addition of 1 c. c. of a 1 per cent solution of $Na_2S_2O_4$ converts the rose tint of the control, more or less, to yellow, while it makes the cysteine red more vivid. With the sodium sulphite procedure (experiments 4, 5, and 6) we have matched cysteine in mixtures of amino-acids and sulphur containing compounds with the same quantity of cysteine in pure solution in water and 0.1 N HCl.

As shown in experiment 7, the sodium sulphite process is more delicate than the alkali-hyposulphite, in that with a given concentration of cysteine in water or 0.1 N HCl it gives more red color than does the alkali-hyposulphite process. Where the solution to be tested for cysteine contains considerable buffering material, such as protein, the sodium sulphite procedure (10 per cent Na_2SO_3 in 0.5 N NaOH) can not be used, since it may not give the necessary alkalinity. In such cases, we have had recourse to the hyposulphite process with strong alkali.

We have indications from more recent work that, with less concentration of sodium sulphite in alkali stronger than 0.5 N NaOH, the sodium sulphite process can be employed even in strongly buffer-

ing solutions. If such a finding should hold in various mixtures, the alkali-hyposulphite process can be dispensed with.[2]

REACTION MODIFIED TO INCLUDE CYSTINE

Of the various compounds, amino acids and thio compounds, which give a brown color with 1.2 naphthoquinone-4-sodium sulphonate and sufficient NaOH to make the final reaction about 0.1 N NaOH, cysteine is the only one that stays red when an alkaline solution of sodium hyposulphite is added. Even cystine and glutathione give a yellow color. When the method is changed so that, after addition of the naphthoquinone, an alkaline solution of anhydrous sodium sulphite is added, cysteine gives a red color and cystine if present in quantities over 100 parts per million slowly gives a slight red.

If, however, the cystine is reduced before addition of the naphthoquinone it can be estimated as cysteine.

The cystine can be reduced to cysteine in various ways. Baumann (1883) found that tin and hydrochloride acid reduced cystine to cysteine. Mörner (1899) showed that KCN acted on cystine with the formation of substances giving the nitroprusside reaction, due presumably to cysteine. Mauthner (1901) found that cystine was slowly reduced by hydrogen sulphide, and Heffter (1907) employed sodium sulphite to bring about this reduction.

In our work we found that sodium hyposulphite ($Na_2S_2O_4$) and sodium sulphite (Na_2SO_3) would reduce cystine and that H_2S would give a slight reduction. These reducing agents have the disadvantages that (1) the reduction takes considerable time and that (2) if any free hyposulphite, sulphite, or hydrogen sulphide are left in the solution they reduce the napthoquinone when it is added and slow up the formation of the complex which gives the red color. This inhibition is especially marked with sodium hyposulphite.

Sodium cyanide on the contrary reduces cystine to cysteine and allows the formation of a red color in the reaction between 1.2 naphthoquinone–4–sodium sulphonate and cysteine.

The procedure in case of cystine is as follows: To 5 c. c. of a solution of cystine in 0.1 N HCl there is added 1 c. c. of a 5 per cent aqueous solution of sodium cyanide. The mixture is allowed to react for ten minutes with an occasional shaking. Then 1 c. c. or 2 c. c. of the napthoquinone, depending on the concentration of cystine, is added, mixed, and followed by 5. c. c. of a 10 per cent solution of sodium sulphite in 0.5 N NaOH. After 10 or 15 minutes' standing of the reacting solutions, 1 c. c. of 2 per cent $Na_2S_2O_4$ is added. Readings are then made.

[2] The application of the cysteine reaction, both procedures, to solutions containing buffering material such as tissue extracts and protein hydrolysates, is now under study in the Hygienic Laboratory. Preliminary experiments indicate that with proper attention to the pH of the solution, cysteine and cystine can be determined in complex mixtures, such as protein hydrolysates.

With concentration of cystine, 400 to 1,000 parts per million, we have had, as a rule, reduction of cystine to cysteine and (90 to 100 per cent) quantitative matching of the cystine + NaCN against a cysteine standard as is shown in experiment 8. Occasionally, however, even at the concentrations mentioned, the cystine solutions reduced by NaCN have not checked so well with the cysteine standard. The falling off in quantitative uniformity is more marked at lower concentrations of cystine. At the level of 100 parts per million cysteine the reduction may indicate only 50 per cent of the theoretical, but usually it runs about 75 per cent. The cause of the discrepancy is being studied, with a realization that the cystine and cysteine solutions, respectively, are not treated exactly alike and, secondly, that the system cysteine⇆cystine is as yet not fully clarified.

When, however, the standard cysteine (as cysteine HCl) was oxidized to cystine, the treatment with sodium cyanide followed by 1.2 naphthoquinone-4-sodium sulphonate and alkaline sodium sulphite gave the same intensity and shade of red as is given by an equivalent amount of cystine similarly treated with sodium cyanide, etc. Experiment 9 illustrates this point.

By means of sodium cyanide reduction, cystine in mixtures of other amino acids and thio compounds can be compared quantitatively with cystine in pure solution, as is shown in experiment 10.

The cyanide has a double function in our experiments. If added to a cystine solution after the addition of the napthoquinone it does not act in a reducing way on cystine; if added to a cysteine solution it checks the tendency to oxidation there might be in the presence of alkali. Secondly, if added to the cystine solution, before addition of the other reagents, it reduces the cystine to cysteine more or less quantitatively.

Various experiments indicate that cysteine solutions or mixtures should be matched against a cysteine standard similarly treated and cystine solutions or mixtures against a cystine standard similarly treated. The standard cysteine and cystine solutions naturally must approximate the quantity of cysteine and cystine, respectively, in the solutions under study.[1]

A COMPOSITE REAGENT—THE 1.2 NAPHTHOQUINONE-4-SODIUM SULPHONATE-SODIUM SULPHITE REAGENT

The cysteine reaction can be done in another way. The naphthoquinone and sulphite are mixed and used as one. The procedure in this method is as follows: To 100 c. c. of a 5 to 10 per cent solution of sodium sulphite in 0.25 N NaOH add 100 mg. of 1.2 naphthoquinone-4-sodium sulphonate and stir. The mixture is a pale yellow

[1] Diluting with water tends to change the color shade. Dilution, if employed, should be made with the same concentration of alkali used in developing the red color.

solution which can be kept for days. We have found it satisfactory after 48 hours when kept in stoppered flasks. To 5 c. c. of the solution under test add 5 c. c. of the beta naphthoquinone-sodium sulphite reagent. Within 30 minutes cysteine gives a strong red, cystine a slight red, and glutathione a pale yellow. The color given by cysteine and cystine are made more vividly red by addition of 1 c. c. of a 2 per cent solution of $Na_2S_2O_4$ in 0.25 N NaOH. All other compounds tested go to pale yellow. Several compounds, namely, cyanacetamide, trinitrotoluol, and diphenylcarbazide give a red color practically at once with the naphthoquinone-sodium sulphite reagent, but this color is discharged to yellow by addition of the sodium hyposulphite. Diphenylcarbazide decolorizes slowly but within five minutes after addition of the hyposulphite it is practically colorless. Table 3 illustrates the findings with this method.

REMARKS ON THE NEW CYSTEINE REACTION

The new cysteine reaction is not given (A) by compounds containing the (SH) group alone; (B) by compounds containing the (NH_2) group alone; (C) by compounds containing (NH_2) and S as in cystine; (D) by mixtures of amino-acids (NH_2 group) and the compounds containing SH; and (E) by compounds containing both SH and (NH_2), but with these groups far apart in the molecule as in reduced glutathione. It is given by cysteine where the SH and NH_2 groups are in close proximity and apparently both groups, SH and NH_2 in close proximity in the molecule are necessary for the reaction with 1.2 naphthoquinone-4-sodium sulphonate. We would expect that compounds containing non-substituted SH and (NH_2) on the same or neighboring carbon atoms, would give the cysteine reaction. A few compounds of this nature we have found in the literature but as yet have not had an opportunity to make them for comparison with cysteine in its reaction with 1.2 naphthoquinone-4-sodium sulphonate. However, so far as we can find, no compounds of this nature aside from cysteine free or combined occur in vegetable or animal tissue or extracts thereof. Therefore, the cysteine test as described may be used in biochemical work as a highly specific test for free cysteine and indirectly for cystine. The new reaction likewise differentiates between cysteine and reduced glutathione, since the latter at least up to 1,000 parts per million does not give the reaction. Glutathione 3,000 parts per million in 0.1 N HCl treated with 1 c. c. of 5 per cent NaCN gives with 1 c. c. of the naphthoquinone and 5 c. c. of 10 per cent Na_2SO_3 in 0.5 N NaOH only a faint red color, while cystine 400 parts per million, similarly treated, gives a strong red color and cysteine with the cyanide added after the naphthoquinone and sulphite gives a strong red. Read in the colorimeter the color given by 3,000 parts per million of glutathione

is too little to be compared with the color given by cystine (reduced) and by cysteine. The glutathione treated by cyanide, however, gives an intense nitroprusside reaction. Thus taken in conjunction with the nitroprusside reaction, it affords the first easy chemical method of distinguishing cysteine from glutathione. The negative reaction of reduced glutathione as compared with cysteine we take as a proof that in glutathione the NH_2 of the cysteine portion is tied as NH. In other words, our work falls in line with the formula given by Quastel, Stewart, and Tunnicliffe,

$$\begin{array}{l} CH_2SH \\ CHNH\text{-}COCH_2CH_2CHNH_2COOH \\ COOH \end{array}$$

When this complex (glutathione) is split by hydrolysis it gives the naphthoquinone reaction for cystine as herein described.

Work is being done on the amplication of the new cysteine reaction to the estimation of cysteine and cystine in presence of glutathione and in extracts of tissues. The reaction has been of use in showing the presence of cystine in glutathione preparations and in determining the purity of such preparations.

Briefly reviewed, the procedures in testing for cysteine and cystine are as follows:

(1) *Cysteine.*—To 5 c. c. of a solution of cysteine in 0.1N acid add 1 c. c. of a 0.5 per cent aqueous solution of 1.2 naphthoquinone-4-sodium sulphonate, mix, add 5 c. c. NaOH (0.25 N or 0.5 N) in the NaOH hyposulphite procedure; or add 5 c. c. 10 per cent Na_2SO_3 in 0.25 N or 0.5 N NaOH, in the Na_2SO_3 procedure; mix and follow by 1 c. c. of 5 per cent aqueous NaCN. Let stand 10 to 20 minutes. A red brown color develops. Add 1 c. c. of a 2 per cent solution of $Na_2S_2O_4$ in 0.25 N or 0.5 N NaOH. The red brown becomes purer red. The sodium sulphite procedure is the better one.

(2) *Cystine.*—To 5 c. c. of the 0.1 N acid solution of cystine add 1 c. c. 5 per cent aqueous NaCN, mix and let stand about 10 minutes. Then proceed as under cysteine but without further addition of cyanide.

(3) *Cysteine.*—In case of the possible presence of compounds like pyrogallol, phloroglucinol, hydroquinone, and pyrrol, the procedure should be as follows: To the solution in 0.1 N HCl add 1 c. c. of 1 per cent NaCN, mix, wait 5 to 10 minutes. Then proceed as in (1) without further addition of cyanide. All solutions compared should have same treatment.

(4) *Cystine.*—In case of possible presence of compounds like pyrogallol, etc., as mentioned in (3), add 1 c. c. 5 per cent NaCN, mix, wait 10 minutes, and proceed by Na_2SO_3 procedure as for cysteine.

PROTOCOL OF EXPERIMENTS

The following experiments show that cysteine can be determined quantitatively in various mixtures by the new cysteine reaction.

Experiment 1.—Solutions (A), (B), (C), and (D) were made so that (A) contained 50 mg. of cysteine hydrochloride in 100 c. c. of water; (B) contained the same quantity of cysteine HCl and also 50 mg. of glycocoll in 100 c. c.; (C) contained 50 mg. of glycocoll and 50 mg. of cystine in 100 c. c.; (D) 50 mg. of glycocoll in 100 c. c.

To 20 c. c. of each solution were added 3 c. c. of a 0.5 per cent solution of 1.2 naphthoquinone-4-sodium sulphonate and 5 c. c. N NaOH. After standing 20 minutes, (A) and (B) were brown red while (C) and (D) were brown yellow. On the addition of 1 c. c. of a 1 per cent solution of $Na_2S_2O_4$ in N NaOH, (A) became red, (B) became red, (C) became yellow, and (D) became pale yellow. The final reaction was roughly 0.18, N NaOH.

Compared in a DuBoscq colorimeter, (A) set at 15 matched (B) at 14.5. (B) =104 per cent of (A). This experiment shows that cysteine can be determined quantitatively in presence of glycocoll.

Experiment 2: Estimation of cysteine in mixture of amino acids.—Stock solutions were made as follows:

(1) 65.1 mg. of cysteine HCl were dissolved in 25 c. c. 0.1 N HCl =2,000 p. p. m. cysteine. 1 c. c. contained 0.2314 mg. of nitrogen.

(2) 49.6 mg. of cystine were dissolved in 25 c. c. 0.1 N HCl. 1 c. c. contained 0.2314 mg. of nitrogen.

(3) 31 mg. of glycocoll in 25 c. c. 0.1 N HCl. 1 c. c. contained 0.2315 mg. of nitrogen.

(4) 74.8 mg. of tyrosine in 25 c. c. 0.1 N HCl. 1 c. c. contained 0.2315 mg. of nitrogen.

(5) 60.9 mg. glutamic acid in 0.1 N HCl. 1 c. c. contained 0.2314 mg. of nitrogen.

As needed, these stock solutions (1 to 5) were diluted with 0.1 N HCl or combined to make the concentration or combination desired. In experiment 2 the solutions and combinations were as follows:

(A) 5 c. c. of cysteine solution, 400 p. p. m. cysteine made by diluting stock solution (1) with 0.1 N HCl.

(B) 5 c. c. of a mixture containing 400 p. p. m. of cysteine and on the nitrogen basis equivalent amounts of cystine, glycocoll, tyrosine, and glutamic acid.

(C) 5 c. c. of a mixture containing 400 p. p. m. of cysteine and glycocoll, tyrosine, and glutamic acid as in (B). This mixture was made by combining 5 c. c. of stock solutions 1, 3, 4, 5, and 5 c. c. 0.1 N HCl.

One c. c. of a 0.5 per cent aqueous solution of 1.2 napthoquinone 4-sodium sulphonate was added to each 5 c. c. and immediately 5 c. c. of a 10 per cent KOH solution.

In ten minutes, (A) was red; (B) was deep brown red; (C) was deep brown red.

There was then added 1 c. c. of a 1 per cent $Na_2S_2O_4$ solution in 10 per cent KOH.

The color became a purer red, easily read in the colorimeter. Following are the readings:

Schreiner colorimeter
Within 5 minutes ..... (A) set at 10
(B) = 10
(C) = 10

Duboscq colorimeter
Within 25 minutes ..... (A) set at 20
(B) = 19
(C) = 20

Duboscq colorimeter
After 3 hours ..... (A) set at 20 (=100)
(B) = 15 (=133)
(C) = 20 (=100)

Schreiner colorimeter
After 3 hrs., 20 min ..... (B) set at 12 (=133)
(C) = 16 (=100)

After 3 hrs., 30 min., 1 c. c. more $Na_2S_2O_4$ in 10 per cent KOH added.

Duboscq colorimeter
After 3 hrs., 40 min ..... (C) set at 20 (=100)
(B) = 15 (=133)

Conclusion.—Experiments 1 and 2 show (1) that cysteine can be determined quantitatively in presence of other amino-acids even in presence of cystine; (2) that amino-acids, aside from cystine do not interfere even with several hours standing; (3) that cystine within a short period 15–25 minutes does not interfere; (4) that cystine slowly gives the reaction by being reduced to cysteine; (5) that comparable results are obtained with wide variation in concentration of the alkali used.

Experiment 3: Determination of cysteine added to urine.—(A) To 9 c. c. of filtered urine were added 1 c. c. of a 0.1 N HCl solution of 2,000 p. p. m. cysteine, 2 c. c. 1.2 naphthoquinone-4-sodium sulphonate, 10 c. c. 10 per cent NaOH, and 1 c. c. 5 per cent aqueous NaCN. After 10 minutes 1 c. c. of 2 per cent $Na_2S_2O_4$ in 10 per cent NaOH was added.

(B) 1 c. c. of a 2,000 p. p. m. cysteine solution in 0.1 N HCl was added to 9 c. c. of H_2O and the solution was treated as above.

(C) 1 c. c. 2,000 p. p. m. cysteine solution +9 c. c. 0.1 N NCl.

The further treatment was as in (A) and (B). Following are the readings:

Duboscq colorimeter

(B) set at 20 (C) = 20
(A) = 18.5 (A) = 20.4
(C) = 18.0

(B) contained 200 p. p. m. cysteine in water.
(C) contained 200 p. p. m. cysteine in 0.1 N HCl.

In (B) some oxidation of the cysteine probably had occurred. Solution (C) 200 p. p. m. cysteine matched urine to which 200 p. p. m. had been added. The cysteine added to urine was determined quantitatively so this batch of urine apparently contained no free cysteine as voided.

Experiment 4: Quantitative estimation of cysteine in mixture of amino-acids by sodium sulphite process.—In Nessler tubes were placed solutions as follows:

(A) 5 c. c. of 100 p. p. m. cysteine (130.2 p. p. m. cysteine HCl) in 0.1 N HCl. Each c. c. contained 0.0116 mg. of nitrogen.

(B) 5 c. c. of 100 p. p. m. of cysteine and, on the nitrogen basis, equivalent amounts of glycocoll, tyrosine, glutamic acid in 0.1 N HCl. Each c. c. contained 0.0116 mg. of nitrogen of each ingredient.

(C) 5 c. c. of a mixture of 100 p. p. m. of cysteine and equivalent amounts of cystine, glycocoll, tyrosine, and glutamic acid in 0.1 N HCl. Each c. c. contained 0.0116 mg. of the nitrogen of each ingredient.

(D) 5 c. c. of 100 p. p. m. cystine and equivalent amounts of glycocoll, tyrosine, and glutamic acid in 0.1 N HCl. Each c. c. contained 0.0116 mg. of the nitrogen of each ingredient.

(E) 5 c. c. of a mixture of glycocoll, tyrosine, and glutamic acid in 0.1 N HCl. Each c. c. contained 0.0116 mg. of nitrogen of each ingredient.

(F) 5 c. c. 0.1 N HCl.

To the 5 c. c. of each of these solutions were added 1 c. c. of a 0.5 per cent solution of 1.2 naphthoquinone-4-sodium sulphonate and 5 c. c. of a 20 per cent solution of Na_2SO_3 in 0.25 N NaOH.

Thirty minutes after adding the Na_2SO_3, readings were made. Solutions (A), (B), and (C) were red; (D), (E), and (F) were yellow. Using the Schreiner colorimetric solutions (A), (B), and (C) were compared. (A) set at 10 matched (B) at 10 and (C) at 10.

After the addition of 1 c. c. 5 per cent aqueous NaCN and 1 c. c. of 1 per cent $Na_2S_2O_4$ in 0.25 N NaOH the readings were made again in the Schreiner colorimeter. With (A) set at 16, (B) and (C) gave readings of 16—a perfect match.

Experiment 5: Quantitative determination of cysteine in mixture of amino acids by sodium sulphite process.—Experiment 5 was like experiment 4, excepting that 5 c. c. of 20 per cent Na_2SO_3 in 0.5 N

NaOH was used in place of Na_2SO_3 in 0.25 N NaOH, and readings were made over several hours.

At 12.16 the Na_2SO_3 solution was added to the mixture of amino acids and 1.2 naphthoquinone.

At 12.18 1 c. c. of a 5 per cent aqueous solution of NaCN was added.

At 12.27 (D), (E), and (F) were yellow; (A), B), and (C) were red. With (A), cysteine alone, set at 16 in the Schreiner colorimeter, (B), cysteine in a mixture of amino acids but no cystine, equalled 16 and (C), containing the same amount of cysteine and also cystine, equalled 16.

Tubes A, B, and C were allowed to stand to determine the effect of time on the color formation. The later readings were as follows:

At 2.00 p. m.:
(A) set at 16.
(B) = 16.
(C) = 12.

At 2.45 p. m.:
(A) set at 16.
(B) = 16.
(C) = 11.

At 3.10 p. m.:
(A) = 16.
(B) = 10.

At 3.50 p. m.:
(A) set at 16.
(B) = 16.
(C) = 10.

Similar results were obtained with cysteine 75 and 50 parts per million, alone and in mixture of various amino acids as given in experiment 5.

Conclusion.—These experiments show that by the use of 1.2 naphthoquinone-4-sodium sulphonate in presence of an alkaline solution of Na_2SO_3, cysteine can be determined quantitatively in the presence of other amino acids, including cystine, provided the colorimetric readings or comparisons are made within 30 minutes after adding the reagents. With longer contact the cystine begins to give the cysteine reaction, since it is reduced by the sodium sulphite. By these methods there has never been obtained more than 80 per cent reduction of cystine to cysteine as determined by increased color on standing in the mixture containing cystine as well as cysteine.

Experiment 6: Quantitative determination of cysteine in presence of thio-compounds and an amino acid.—(A) five c. c. aqueous solution of a mixture of thiocresol, thiobarbituric acid, thioacetic acid, glycocoll, and cysteine (as cysteine hydrochloride) of such concentration that each ingredient was at the concentration of 100 parts per million parts of water.

(B) Five c. c. of the same mixture, with no cysteine.

(C) Five c. c. No. B + 1 c. c. 28 per cent NH_4OH.

(D) One hundred p. p. m. cysteine (as 130. 2 p. p. m. cysteine HCl) in H_2O.

To each solution were added 1 c. c. 1.2 naphthoquinone-4-sodium sulphonate and 5 c. c. of a 10 per cent solution of anhydrous sodium sulphite in 0.5 N NaOH. On standing 10 minutes, (A) was reddish brown, (B) was pale yellow, (C) was deep brown red, (D) reddish brown, and (A) and (D) matched in Nessler tubes. In thirty minutes, (A) was good red, (B) pale yellow, (C) brown, and (D) good red. Reading in Duboscq colorimeter was as follows: (A) set at 30 = golden; (D) = 29.9.

One c. c. of a 2 per cent solution of sodium hyposulphite in 0.5 N NaOH was added to each tube. (A) became intense red, (B) pale yellow, (C) slight orange, and (D) intense red. (A) and (D) matched in Nessler tubes.

In the Duboscq colorimeter, A set at 25 = 96 per cent; D = 24 = 100 per cent.

After 2½ hours (A) was red, (B) was yellow, (C) was yellow, and (D) was red.

Experiment 7. A comparison of the sodium sulphite method with the hyposulphite method.—(A) Five c. c. 200 p. p. m. cysteine as cysteine HCl in H_2O + 1 c. c. 1.2 naphthoquinone-4-sodium sulphonate + 5 c. c. 0.5 N NaOH + 1 c. c. 5 per cent aqueous NaOH. After ten minutes' standing 1 c. c. of a 2 per cent solution of $Na_2S_2O_4$ in 0.5 N NaOH was added. The result was a slightly red solution.

(B) Five c. c. 200 p. p. m. cysteine solution as above + 1 c. c. of the naphthoquinone + 5 c. c. 20 per cent Na_2SO_3 in 0.5 N NaOH.

After 10 minutes, 1 c. c. 5 per cent aqueous NaCN and 1 c. c. 2 per cent $Na_2S_2O_4$ were added to (B).

(B) was a better red than (A).

Thirteen c. c. (B) − 6 c. c. matched 13 c. c. (A) in Nessler tubes.

Seven c. c. B = 13 c. c. (A).

Therefore (A) = approximately 55 per cent of (B).

Experiment 8: Reduction of cystine by NaCN and estimation of cystine as cysteine by the naphthoquinone method.—(A) five c. c. 400 p. p. m. cystine in 0.1 N HCl + 1 c. c. 5 per cent NaCN, wait 10 minutes and add 1 c. c. 0.5 per cent solution of the naphthoquinone, mix and add 5 c. c. 10 per cent Na_2SO_3 in 0.25 N NaOH. Let stand 15 minutes and add 1 c. c. 2 per cent $Na_2S_2O_4$ in 0.25 N NaOH.

(B) Duplicate of (A).

(C) five c. c. 400 p. p. m. cystine + 1 c. c. of the naphthoquinone + 5 c. c. of the alkaline Na_2SO_3 + 1 c. c. NaCN. After 15 minutes add 1 c. c. 2 per cent $Na_2S_2O_4$ in 0.25 N NaOH.

(D) five c. c. cysteine 400 p. p. m. treated like (C).

(E) Duplicate of (D).

(A), (B), (D), (E) became red, (C) stayed light yellow. Comparisons were made in the Duboscq colorimeter with (D) as standard. Readings were as follows:

(D) as standard set at 10.
(A) = 10.
(B) = 10.
(E) = 10.

Experiment 9: Comparison of cysteine (oxidized) with cystine from wool.—Five c. c. of a 2,000 parts per million of cysteine as cysteine HCl were made alkaline with NH_4OH and warmed on the hot plate until the nitroprusside reaction was negative and a precipitate of cystine occurred. The solution was then made to 25 c. c. with 0.1 N HCl and warmed. A clear solution was made—now equal to 400 p. p. m. cystine in 0.1 N HCl.

Five c. c. of this cystine (oxidized cysteine) 400 p. p. m. (A) were compared with 5 c. c. of 400 p. p. m. of cystine (B) in 0.1 N HCl.

To each sample in Nessler tubes was added 1 c. c. of 5 per cent aqueous NaCN and the mixture allowed to stand 8 minutes. Then 1 c. c. 1.2 naphthoquinone-4-sodium sulphonate and 5 c. c. fresh 10 per cent Na_2SO_3 in 0.5 N NaOH was added to each tube. Read in the Duboscq colorimeter, (B) set at 20 matched the color of (A) at 20.1.

Experiment 10: Estimation of cystine in mixtures of amino acids and thio compounds, sodium cyanide as reduction agent.—(A) five c. c. 400 p. p. m. cystine in 0.1 N HCl + 1 c. c. 5 per cent aqueous NaCN. Let stand 10 minutes and add—

1 c. c. of the naphthoquinone and immediately 5 c. c. of 10 per cent Na_2SO_3 in 0.5 N NaOH.

(B) Five c. c. of a mixture containing 400 p. p. m. cystine and on the nitrogen basis equivalent amounts of tyrosine, glycocoll, glutamic acid in 0.1 N HCl + 1 c. c. 5 per cent aqueous NaCN. Let stand 10 10 minutes and add—

1 c. c. of the naphthoquinone and 5 c. c. of 10 per cent Na_2SO_3 in 0.5 N NaOH.

(C) Five c. c. of mixture containing 400 p. p. m. cystine, glycocoll, tyrosine, and thioacetic acid, respectively, and saturated with thiocresol + 1 c. c. 5 per cent aqueous NaCN. Let stand 10 minutes and add—

1 c. c. of the naphthoquinone and 5 c. c. of 10 per cent Na_2SO_3 in 0.5 N NaOH.

(D) Five c. c. 400 p. p. m. cystine in 0.1 N HCl + 1 c. c. of the naphthoquinone and 5 c. c. of 10 per cent Na_2SO_3 in 0.5 N NaOH.

(A), (B), and (C) became brown red. (D) became yellow orange. With (A) as standard set at 20, (B) read 19.6 and (C) 18.

One c. c. of 2 per cent $Na_2S_2O_4$ in 0.5 N NaOH was then added. Solutions (A), (B), and (C) became a purer red. (D) became a faint orange. With (A) as standard set at 20, (B) read 20.2 and (C) 19.2.

Experiment 10 shows that, by means of reduction with NaCN, cystine in mixtures of other amino acids and thio compounds can be determined quantitatively.

SUMMARY

A highly specific reaction is herein described for cysteine and indirectly for cystine. Two modifications of the reaction are given—the alkali-hyposulphite process and the alkali-sodium sulphite process.

With the alkali-hyposulphite process, many substances give color, generally brown or red with the napthoquinone and alkali, but this color is, in general, discharged to yellow on addition of sodium hyposulphite. The color given by cystine and glutathione are thus discharged. Cysteine, however, gives a more vivid red.

In the sodium sulphite process the addition of the napthoquinone followed by an alkaline solution of anhydrous sodium sulphite, produces a red color with cysteine, while most other compounds give only a yellow color. Cystine, if present in concentrated solution, gives a slight red, due to reduction to cysteine. The further addition of alkaline sodium hyposulphite makes the cysteine red more vividly red, while practically all other compounds treated are made yellow. Within 25 minutes the color given by cystine in concentration of 400 parts per million and less is practically negligible.

The sodium sulphite process is the more precise and delicate. It is clearly sensitive to 20 parts per million of cysteine in pure solution in 0.1 N HCl.

By either process independently, cysteine can be estimated quantitatively in mixtures with other amino acids and sulphydryl compounds.

The cysteine reaction is given by cystine after the latter has been reduced. Of the reducing agents tried sodium cyanide was found to be most suitable.

The color given by cystine reduced by sodium cyanide and treated as above tends to be less than that given by an equivalent amount of cysteine as standard. This is especially so with lower concentrations of cystine. Cystine, however, in mixtures of amino acids and thio-compounds in 0.1 N HCl can be quantitatively matched against a pure cystine standard.

Neither reduced nor oxidized glutathione gives the new cysteine reaction.

Glutathione split into cystine and glutamic acid by acid hydrolysis can be matched quantitatively against a standard cystine solution.

Of some eighty compounds tested, only four tend to interfere with the naphthoquinone-cysteine reaction, namely, pyrogallol,

phloroglucinol, pyrrol, and, to a lesser degree, hydroquinone. In the sodium sulphite modification, the interference is less marked. With the use of NaCN, to keep out interference by pyrogallol, phloroglucinol, and pyrrol, the specificity in the sodium sulphite procedure has so far been absolute.

TABLE 1.—*Comparative reaction of cysteine and analogous compounds, amino acids, amines, thio-compounds, etc., with 1.2 naphthoquinone-4-sodium sulphonate (I) and alkali and reducing agents such as Na_2SO_3 and $Na_2S_2O_4$.*

Substance	Parts per million (a)	Color with (I)+N/4-N/2 NaOH (b)	Color after addition of $Na_2S_2O_4$ (c)	Color with (I) and Na_2SO_3 in N/4-N/2 NaOH (d)	Color after addition of $Na_2S_2O_4$ (e)
(1) Cysteine [1]	400	Brown red	Red	Red	Bright red.
(2) Cystine [1]	400	do	Pale yellow	Light yellow	Light yellow.
(3) Glutathione [1]	1,000	do	do	do	Do.
(4) dl Alanine	400	do	do	do	Do.
(5) Aspartic acid	400	do	do	do	Do.
(6) Asparagine	400	do	do	do	Do.
(7) Glycocoll	400	do	do	do	Do.
(8) Glutamic acid	400	do	do	do	Do.
(9) Histidine	400	do	do	do	Do.
(10) Leucine	400	do	do	do	Do.
(11) Lysine	400	do	do	do	Do.
(12) Phenylalanine	400	do	do	do	Do.
(13) Tyrosine	400	do	do	do	Do.
(14) Tryptophane	400	do	do	do	Do.
(15) Anthranilic acid	400	Orange	do	do	Do.
(16) Urea	500	Yellow	do	do	Do.
(17) Uric acid	800	do	do	do	Do.
(18) Alloxan	400	Brown	do	do	Do.
(19) Aminophenol	400	do	do	do	Do.
(20) Anilin	400	Red orange	do	Yellow	Do.
(21) Creatine	400	Yellow	do	do	Pale yellow.
(22) Creatinine	400	do	do	do	Do.
(23) Guanidine HCl	400	Sl. red	do	do	Do.
(24) Histamine	400	Brown	do	do	Do.
(25) Pentamethylene diamine (cadaverine).	0.5 c. c.	Sl. greenish	do	do	Do.
(26) Hydrogen sulphide.	Sat. aq. soln.	Brown	Light yellow	do	Yellow.
(27) Thioacetic acid	500	Yellow	do	do	Do.
(28) Thiobarbituric acid.	500	Orange	do	do	Do.
(29) Thioglycollic acid	500	Sl. red	do	do	Do.
(30) Thiolactic acid	500	Yellow	do	do	Do.
(31) Thiosalicylic acid-Mono. [1]	500	Sl. brown	do	do	Do.
(32) Thiosalicylic acid-Di. [1]	Sat. soln.	do	do	do	Do.
(33) Thiocresol	Sat. soln.	Yellow	do	do	Do.
(34) Thio beta naphthol.	Sat. soln.	Brownish	do	do	Do.
(35) Thiophene	1 c. c.	Yellow	do	Sl. brown	Do.
(36) Thiophenol	Sat. soln.	Brownish	do	Yellow	Do.
(37) Thiourea	500	Brown	do	do	Do.
(38) Phenylthioglycol-o-carboxylic acid. [1]	500	Yellow red	do	Sl. brown	Do.
(39) KSCN	2,000	Yellow	do	Yellow	Do.
(40) Norleucine	500	Brownish	do	do	Do.
(41) L. Proline [2]	500	Brownish red	do	do	Do.
(42) Serine [3]	500	Brown	do	do	Do.
(43) Valine [3]	500	do	do	do	Do.
(44) Casein hydrolysate. [1]	Conc.	Brown red and ppt.	Yellowish ppt.	Sl. blue and ppt.	Colorless and ppt.
(45) Gelatine hydrolysate. [1]	Conc.	Brown red soln.	Yellow	Blue soln	Colorless.

[1] Substances made by the author. Substances with source not noted were commercial samples.
[2] The proline was obtained from P. R. Dawson, Bureau of Plant Industry, United States Department of Agriculture.
[3] The serine and valine were obtained from D. B. Jones, Protein Investigation Laboratory, Bureau of Chemistry, United States Department of Agriculture.

TABLE 2.—*Comparative reaction of cysteine and miscellaneous compounds with 1.2 naphthoquinone-4-sodium sulphonate (I), alkali, and Na_2SO_3 and $Na_2S_2O_4$*

Substance	Parts per million (a)	Color with I+NaOH (b)	Color after addition of $Na_2S_2O_4$ (c)	Color with I and Na_2SO_3 in 0.25–0.5 M NaOH (d)	Color after addition of $Na_2S_2O_4$ (e)
(1) Cysteine	400	Brown red	Red	Red	Bright red.
(2) Acetaldehyde	10% aq. soln.	Yellow	Yellow	Yellow	Yellow.
(3) Acetone	20% aq. soln.	Sl. red	do	do	Do.
(4) Adrenaline	500	Blue	do	Blue green	Do.
(5) Ammonium hydroxide.	5% aq. soln.	Green brown	do	Brownish	Do.
(6) Antipyrene	500	Pale yellow	Pale yellow	Pale yellow	Pale yellow.
(7) Arsphenamine	500	Deep red	Yellow	Yellow	Yellow.
(8) Neoarsphenamine	1,000	Yellow	do	do	Do.
(9) Atoxyl	500	Brown red	do	do	Do.
(10) Sulpharsphenamine.	1,000	do	do	do	Do.
(11) Benzidine	500	Red	do	Red	Do.
(12) Cyanacetamide	500	do	do	Yellow	Do.
(13) Dextrose	5,000	Yellow	do	do	Do.
(14) Indol	500	Brown green	do	do	Do.
(15) Catechol	500	Brown	Pale yellow	Pale yellow	Pale yellow.
(16) Hydroquinone	500	do	Sl. brown red or yellow.	Brown	Yellow with sl. rose tinge.
(17) Phenol	500	Yellow	Yellow	Yellow	Yellow.
(18) Phloroglucinol	500	Brown red	Red fades to orange.	Yellow or faint red.	Yellow or faint red.
(19) Resorcine	500	do	Yellow	Yellow	Yellow.
(20) Pyrogallol	500	Red	Brownish red	Brown	Sl. red fades to orange.
(21) Apomorphine	500	Brown	Yellow	Yellow	Yellow.
(22) Morphine sulphate.	500	Yellow	do	do	Do.
(23) Caffeine	500	Colorless	Colorless	Colorless	Colorless.
(24) Piperine	Sat. aq. soln.	Yellow	Yellow	Yellow	Yellow.
(25) Piperidine	500	Red	do	do	Do.
(26) Nicotine	500	Brown	do	do	Do.
(27) Phenylhydrazine	500	Yellow	do	do	Do.
(28) Picric acid	500	do	do	do	Do.
(29) Pyruvic acid	500	Sl. red	do	do	Do.
(30) Piperazine hydrate.	500	Yellow	do	do	Do.
(31) Pyrrol (dark)	500	Dark green	Brown red	Dark blue green.	Brown amber.
(32) Tetraiodo pyrrol (Iodol).	Sat. aq. soln.	Yellow	Yellow	Yellow	Yellow.
(33) Phenetidine	500	Red	do	do	Do.
(34) Ortho tolidine	Sat. aq. soln.	do	do	Sl. yellow	Do.
(35) Sodium naphthionate.	do	Yellow	do	do	Do.
(36) Diphenylcarbazide.	500	Sl. red	do	Sl. orange	Do.
(37) Phenylenediamine (Para).	400	Purple	do	do	Do.
(38) Toluylenediamine (1.3.4).	400	do	do	do	Do.
(39) Trinitrotoluol	500 (sat. sol.)	Red	do	Orange	Do.

TABLE 3.—*Comparative reaction of cysteine and other compounds with a reagent consisting of a mixture of 5 to 10 per cent sodium sulphite in 0.25 N NaOH and 0.1 per cent 1.2 naphthoquinone-4-sodium sulphonate. 5 cc. of reagent is added to 5 cc. of a 0.1 N HCl solution of compound tested*

Substance	Parts per million (a)	Color on addition of 5 cc. reagent (b)	Color in 30 minutes (c)	Color on addition of 1 cc. 2% $Na_2S_2O_4$ in 0.25 N NaOH (d)
(1) Cysteine	400	Pale yellow	Red	Strong red.
(2) Cystine	400	do	Sl. red	Red.
(3) Glutathione	3,000	do	Pale yellow	Pale yellow.
(4) Glutamic acid	2,000	do	do	Do.
(5) Glycocoll	2,000	do	do	Do.
(6) Tyrosine	2,000	do	do	Do.
(7) Anthranilic acid	500	do	do	Do.
(8) Thiourea	500	do	do	Do.
(9) Thiobarbituric acid	500	do	do	Do.
(10) Thiocresol	[1] 1,000	do	do	Do.
(11) Adrenaline	500	do	Green blue	Do.
(12) Antipyrine	500	do	Pale yellow	Do.
(13) Benzidine	500	do	Orange	Do.
(14) Caffein	500	do	Pale yellow	Do.
(15) Cyanacetamide	500	Sl. red	Red	Do.
(16) Dextrose	5,000	Pale yellow	Yellow	Do.
(17) Diphenylcarbazide	[1] 500	Red	Red	Do.
(18) Guanidine HCl	500	Pale yellow	Pale yellow	Do.
(19) Hydroquinone	500	do	Yellow	Do.
(20) Indol	500	Yellow (turbid)	Pale yellow	Pale yellow (turbid).
(21) Phenol	500	Pale yellow	do	Pale yellow.
(22) Phenylhydrazine	500	P. yellow (turbid).	P. yellow (turbid).	Pale yellow (turbid).
(23) Phloroglucinol	500	Yellow	do	Do.
(24) Piperazine hydrate	500	do	do	Do.
(25) Piperine	[1] 500	do	do	Do.
(26) Potassium sulphocyanate	2,000	do	do	Do.
(27) Pyrrol	500	Pale yellow	Yellow	Pale yellow.
(28) Pyrogallol	500	do	do	Do.
(29) Trinitrotoluol	[1] 500	Sl. red	Good red	Do.
(30) o-Tolidine	500	Pale yellow	Pale yellow	Do.
(31) Urea	500	do	do	Do.

[1] Suspension.

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PUBLIC HEALTH ENGINEERING ABSTRACTS

Report of committee on communicable diseases affecting man, their relationship to the milk supply and to the public health. John L. Rice. *Fourteenth Annual Report,* International Association of Dairy and Milk Inspectors, 1925, pp. 51–61. (Abstracted by W. W. White.)

The author states that, during the year 1924, 50,000,000,000 pounds of milk were used in the United States for household purposes. With the many persons coming in contact with the milk and with many chances of infection, there were few epidemics traced to milk. It was concluded that either a failure is being made of properly placing the responsibility of diseases or epidemics on milk or else the methods now in general use are controlling the situation in the majority of instances.

Three safeguards to decrease the hazards of milk consumption are suggested: Pasteurization, sanitary methods of production and distribution, and the tuberculin testing of cattle. The article reviews Doctor Price's report for the Committee on Pasteurization of Milk and Cream, 1924, and mentions other outbreaks of typhoid fever and scarlet fever. Some mention is made of typhoid fever carriers and diphtheria carriers.

A study of commercial pasteurizers in Boston. Alexander R. Tolland. *Fourteenth Annual Report*, International Association of Dairy and Milk Inspectors, 1925, pp. 62–69. (Abstracted by W. W. White.)

This article shows that properly designed and constructed equipment will give the maximum efficiency provided it is operated by intelligent workmen. Positive holdings shows highest elimination of bacteria. At least 95 per cent should be eliminated after pasteurization.

The soaker type of bottle washers turns out bottles as nearly sterile as is possible. Hand washed bottles show highest counts, varying from 20 to 16,000 per cubic centimeter. Dairy inspection, country creamery inspection, plant inspection, the taking of temperatures, sediment tests, acidity tests, direct microscopic work, and reductase tests should be carried on with renewed vigor, as processing will eliminate only a certain percentage of bacteria.

The bacterial content of ice cream. A report of experiments in bacterial control in six commercial plants. N. E. Olson and A. C. Fay. Kansas Agricultural Experiment Station, Manhattan, Kans. *Journal of Dairy Science*, vol. 8, No. 5, September, 1925, pp. 415–444. (Abstracted by R. E. Tarbett.)

Six plants were selected for the work, four days being spent at each plant. No change was made in the usual plant methods of operation for the first two days, while on the last two the entire process was supervised, the faulty methods observed during the first two days being corrected as far as possible.

Methods of sampling and bacteriological methods are outlined. Results are given in bacteria per gram. Standard methods are used. Since conditions varied in the plants and methods were not identical, the methods employed and the results obtained are discussed for each plant.

Tables are given showing (1) the bacteria count per gram of ingredients; (2) number of bacteria per gram of ice cream mix at various stages of manufacture; (3) per cent of the total count due to each ingredient and per cent composition of the mix; (4) the average counts for the two days unsupervised and for the two days under supervision. The results indicated that, under proper operating conditions, a low count cream could be obtained. The average count for all the unsupervised finished ice cream was 390,225, as compared with 39,127 for the supervised. The highest count under the supervised was 91,000, and the lowest 3,200. Some of the conclusions arrived at are as follows:

Cream and milk are the most important source of bacteria in the raw ice cream mix. In most instances these products supplied over 99 per cent of the total bacteria in the raw mix.

Thorough washing with an alkaline washing powder and sterilization of all equipment with live steam are essential factors in the production of ice cream of low bacterial content.

Conveying pipes, pumps, and homogenizers can not be properly cleaned without being taken apart.

Hypochlorite solutions, when properly used, give satisfactory results in sterilizing ice cream plant equipment.

The use of pasteurizing equipment for two or more successive mixes without washing may result in high counts, due to the growth of thermophilic bacteria.

Proper pasteurization is the most important factor governing the bacterial count of ice cream. Pasteurization at 145° F. for 30 minutes and homogenization at pasteurizing temperature result in counts of less than 100,000 bacteria per gram in the finished ice cream, provided equipment contamination is reduced to a minimum. These results were obtained even with raw mixes containing as high as 34,000,000 bacteria per gram.

Ice cream mix should be cooled as soon as possible after homogenizing, to prevent bacterial growth.

It is possible and practicable to produce ice cream containing less than 100,000 bacteria per gram under all plant conditions observed, provided that efficient pasteurization is practiced, the temperature is controlled during aging, and the equipment is properly washed and sterilized. High bacterial counts indicate carelessness at some point in the manufacturing process which, in turn, indicates an undesirable, if not an unsafe, product. There can be no valid excuse for ice cream containing more than 100,000 bacteria per gram as determined by the plate method.

Pasteurized Milk. Anon. *Monthly Bulletin*, Indiana State Board of Health, vol. 29, No. 2, February, 1926, pp. 19–20. (Abstracted by Isador Mendelsohn.)

This article presents a résumé of the results of investigators regarding the infection of infants and children with bovine tuberculosis,

and the results of the pasteurization of milk in destroying the tubercle bacillus, the typhoid bacillus, and other pathogenic organisms. The percentage of tuberculous children and infants infected with the bovine tubercle bacillus varies from 10 to 25 according to various authorities.

DEATH RATES IN A GROUP OF INSURED PERSONS

RATES FOR PRINCIPAL CAUSES OF DEATH FOR MARCH AND THE FIRST QUARTER, 1926

The accompanying table is taken from the Statistical Bulletin for April, 1926, published by the Metropolitan Life Insurance Co., and presents the mortality experience of the industrial insurance department of the company for March, 1926, as compared with February, and with March, and year 1925. The rates are based on a strength of approximately 17,000,000 insured persons in the industrial populations of the United States and Canada.

The death rate in this group of persons for March, 1926, was 12.1 per 1,000—higher than for any month since March, 1923. It represents an increase of 23.5 per cent over the rate for February, 1926, and of 15.2 per cent over the rate for March, 1925.

This high death rate for March is attributed almost entirely to influenza and pneumonia, the influenza death rate increasing from 37 per 100,000 in February to 76.1 in March, and the pneumonia death rate from 137.6 in February to 194 in March. The Bulletin states:

> Contrary to what happened in February, * * * the higher influenza death rate in March was accompanied not only by a very considerable rise in pneumonia mortality, but by higher rates for the "degenerative" diseases and for puerperal conditions. It is now evident that we are experiencing a fairly general outbreak of influenza, which, while of above-average severity, can not be compared at all with conditions during the major pandemics of 1918, 1919, and 1920. Influenza and influenzal pneumonia are causing death this year at about the same rate as in the outbreak of the early months of 1922. Conditions are by no means as serious as at this time in 1923. As in former relatively minor outbreaks of influenza, it is again evident that the above-average prevalence of this disease is, *per se*, entirely capable of raising the general death rate very materially. This is true not only because influenza and pneumonia are so frequently the *direct* cause of death, but because they are hastening causes in the case of thousands of persons who suffer from chronic kidney disease or chronic heart disease. There is always a serious public health problem when epidemic influenza prevails, even though the type be relatively mild.

A new high death rate for measles was recorded for March—21.5 per 100,000—the nearest approach being 19.5 for March, 1920.

Whooping cough also showed an increased death rate in March as compared with February, 1926, and with March, 1925.

Tuberculosis recorded the usual seasonal increase over the February rate, but the death rate from this cause was practically the same as the rate for March, 1925.

Diphtheria and scarlet fever continued to show improvement in March.

Death rates (annual basis) for principal causes per 100,000 lives exposed, February and March, 1926, and March and year, 1925

[Industrial department, Metropolitan Life Insurance Co.]

Cause of death	Rate per 100,000 lives exposed [1]			
	March, 1926	February, 1926	March, 1925	Year 1925 [2]
Total, all causes	1,210.6	982.7	1,045.2	906.9
Typhoid fever	2.4	2.6	2.4	4.6
Measles	21.5	13.0	3.5	3.3
Scarlet fever	4.7	4.6	6.2	3.5
Whooping cough	13.6	7.4	7.0	7.7
Diphtheria	9.2	9.6	11.7	10.6
Influenza	76.1	37.0	48.7	21.9
Tuberculosis (all forms)	115.2	98.3	115.5	98.0
Tuberculosis of respiratory system	100.4	87.3	101.2	85.8
Cancer	77.1	69.1	71.2	70.5
Diabetes mellitus	21.6	15.8	18.2	15.2
Cerebral hemorrhage	68.4	59.6	59.5	53.5
Organic diseases of heart	174.3	144.2	148.9	126.6
Pneumonia (all forms)	194.0	137.6	143.1	86.5
Other respiratory diseases	18.8	15.9	19.0	13.3
Diarrhea and enteritis	16.9	15.0	17.2	36.6
Bright's disease (chronic nephritis)	91.8	78.8	78.3	69.8
Puerperal state	17.4	14.5	19.5	16.5
Suicides	7.0	5.6	7.9	6.9
Homicides	6.5	4.9	6.6	7.2
Other external causes (excluding suicides and homicides)	55.7	52.4	53.5	64.2
Traumatism by automobiles	9.6	11.2	14.2	16.5
All other causes	218.3	196.8	207.2	190.5

[1] All figures include infants insured under 1 year of age.
[2] Based on provisional estimate of lives exposed to risk in 1925.

MORTALITY DURING THE FIRST QUARTER OF 1926

The health conditions in this group for the first quarter of 1926 were not quite as good as for the corresponding periods of 1925 and 1924, due to the unfavorable record for March. The death rate for the first quarter of 1926 was 10.6 per 1,000, as compared with 10.1 for the corresponding months of 1925.

The rate of 10.6 is not a high figure for the winter months. While it is higher than the rates for the first quarters of recent years, it is lower than the average of several years back. The increase in the rate this year is attributed to the recrudesence of influenza and pneumonia and the consequent increased mortality from the "degenerative" diseases.

The death rates per 100,000 for the first quarters of 1924, 1925, and 1926, for white and colored policyholders separately are given as follows:

White			Colored		
Jan.-Mar., 1926	Jan.-Mar., 1925	Jan.-Mar., 1924	Jan.-Mar., 1926	Jan.-Mar., 1925	Jan.-Mar., 1924
967.3	928.6	929.8	1,724.2	1,626.1	1,553.7

DEATHS DURING WEEK ENDED MAY 15, 1926

Summary of information received by telegraph from industrial insurance companies for week ended May 15, 1926, and corresponding week of 1925. (From the Weekly Health Index May 19, 1926, issued by the Bureau of the Census, Department of Commerce)

	Week ended May 15,1926	Corresponding week 1925
Policies in force	64, 410, 614	59, 818, 421
Number of death claims	13, 629	11, 482
Death claims per 1,000 policies in force, annual rate	11. 0	10. 0

Deaths from all causes in certain large cities of the United States during the week ended May 15, 1926, infant mortality, annual death rate, and comparison with corresponding week of 1925. (From the Weekly Health Index, May 19, 1926, issued by the Bureau of the Census, Department of Commerce)

City	Week ended May 15, 1926		Annual death rate per 1,000 corresponding week, 1925	Deaths under 1 year		Infant mortality rate, week ended May 15, 1926 [2]
	Total deaths	Death rate [1]		Week ended May 15, 1926	Corresponding week, 1925	
Total (67 cities)	7,381	13. 4	13. 2	909	875	[3] 74
Albany [4]	45	19. 9	14. 2	5	4	105
Atlanta	75			12	12	
White	40			6		
Colored	35	([5])		6		
Baltimore [4]	239	15. 7	15. 5	35	26	102
White	177			25		89
Colored	62	([5])		10		162
Birmingham	65	16. 5	19. 3	10	15	
White	30			4		
Colored	35	([5])		6		
Boston	244	16. 3	14. 4	24	38	68
Bridgeport	39			5	2	85
Buffalo	150	14. 5	13. 9	27	20	113
Cambridge	26	11. 3	12. 2	0	3	0
Camden	35	14. 2	13. 0	3	3	51
Chicago [4]	741	12. 9	11. 2	77	86	68
Cincinnati	150	19. 1	15. 5	17	13	106
Cleveland	218	12. 1	10. 6	25	19	65
Columbus	77	14. 3	16. 4	10	4	92
Dallas	34	9. 2	10. 8	5	7	
White	28			4		
Colored	6	([5])		1		
Denver	86	16. 0	15. 0	12	6	
Des Moines	29	10. 1	10. 1	0	6	0
Detroit	332	13. 9	10. 3	66	43	106
Duluth	31	14. 6	8. 0	1	7	23
El Paso	28	13. 9	20. 4	11	7	
Erie	34			6	2	114
Fall River [4]	30	12. 1	12. 1	3	6	44
Flint	29	11. 6	12. 0	10	9	165
Fort Worth	36	12. 3	10. 9	4	1	
White	30			3		
Colored	6	([5])		1		
Grand Rapids	39	13. 2	11. 9	8	3	116
Houston	33	10. 4	17. 4	3	8	
White	19			2		
Colored	14	([5])		1		
Indianapolis	112	16. 3	12. 2	11	9	81
White	92			6		51
Colored	20			5		275
Jacksonville, Fla	58	28. 8	26. 8	6	7	125
White	24			3		98
Colored	34			3		172
Jersey City	51	8. 4	11. 4	5	7	35

[1] Annual rate per 1,000 population.
[2] Deaths under 1 year per 1,000 births. Cities left blank are not in the registration area for births.
[3] Data for 61 cities.
[4] Deaths for week ended Friday, May 14, 1926.
[5] In the cities for which deaths are shown by color, the colored population in 1920 constituted the following percentages of the total population: Atlanta 31, Baltimore 15, Birmingham 39, Dallas 15, Fort Worth 14, Houston 25, Kansas City, Kans., 14, Louisville 17, Memphis 38, Nashville 30, New Orleans 26, Norfolk 38, Richmond 32, and Washington, D. C., 25.

Deaths from all causes in certain large cities of the United States during the week ended May 15, 1926, infant mortality, annual death rate, and comparison with corresponding week of 1925. (From the Weekly Health Index, May 19, 1926, issued by the Bureau of the Census, Department of Commerce)—Continued

City	Week ended May 15, 1926		Annual death rate per 1,000 corresponding week, 1925	Deaths under 1 year		Infant mortality rate, week ended May 15, 1926
	Total deaths	Death rate		Week ended May 15, 1926	Corresponding week, 1925	
Kansas City, Kans.	32	14.4	13.9	8	3	139
White	26			5		105
Colored	6	(5)		3		394
Kansas City, Mo.	89	12.6	11.4	10	6	
Los Angeles	231			15	28	42
Louisville	86	14.8	13.1	10	6	86
White	64			7		70
Colored	22	(5)		3		188
Lowell	33	15.6	9.5	3	4	56
Lynn	20	10.1	15.2	3	4	75
Memphis	59	17.6	16.7	5	8	
White	27			3		
Colored	32	(5)		2		
Milwaukee	117	12.2	13.3	15	17	69
Minneapolis	112	13.7	13.5	15	11	83
Nashville [4]	50	19.1	17.6	4	4	
White	26			2		
Colored	24	(5)		2		
New Bedford	27	11.8	14.4	7	7	122
New Haven	7	2.0	12.2	1	6	14
New Orleans	135	17.0	18.4	16	19	
White	76			10		
Colored	59	(5)		6		
New York	1,441	12.8	13.5	181	169	73
Bronx borough	165	9.9	11.4	14	22	46
Brooklyn borough	507	12.0	11.6	77	62	78
Manhattan borough	592	15.9	18.0	72	73	80
Queens borough	126	9.2	9.0	14	11	63
Richmond borough	51	19.2	16.6	4	1	70
Newark, N. J.	119	13.7	13.9	16	18	77
Norfolk	30			3	2	56
White	7			0		0
Colored	23	(5)		3		149
Oakland	43	8.8	9.0	2	3	23
Oklahoma City	22			1	3	
Omaha	61	15.0	14.5	4	7	42
Paterson	35	12.9	10.7	5	4	87
Philadelphia	493	13.0	14.1	52	58	69
Pittsburgh	163	13.5	14.4	28	11	93
Portland, Oreg.	52	9.6	10.7	1	5	10
Providence	59	11.5	15.4	5	10	41
Richmond	48	13.4	14.8	4	7	50
White	31			2		39
Colored	17	(5)		2		70
Rochester	88	14.5	10.0	11	7	88
St. Louis	209	13.3	13.5	19	11	
St. Paul	49	10.4	11.9	2	5	18
Salt Lake City [4]	37	14.7	12.7	5	1	69
San Antonio	59	15.5	16.8	12	15	
San Diego	37	18.2	15.7	4	1	84
San Francisco	119	11.1	13.9	6	12	36
Schenectady	16	9.0	10.1	1	2	29
Seattle	70			2	3	19
Somerville	17	9.0	13.7	4	3	104
Spokane	21	10.1	12.4	1	2	23
Springfield, Mass.	51	18.7	11.0	8	3	116
Syracuse	40	11.5	13.2	5	6	63
Tacoma	29	14.5	12.0	2	5	47
Toledo	77	14.0	13.4	6	9	58
Trenton	35	13.8	14.2	4	5	67
Washington, D. C.	151	15.8	13.1	23	18	131
White	93			15		124
Colored	58	(5)		8		146
Waterbury	19			6	4	129
Wilmington, Del.	27	11.5	12.0	3	6	70
Worcester	53	14.5	17.8	7	7	81
Yonkers	25	11.5	13.8	2	8	45
Youngstown	42	13.7	9.8	11	5	140

For footnotes 4 and 5 see p. 1061.

PREVALENCE OF DISEASE

No health department, State or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring

UNITED STATES

CURRENT WEEKLY STATE REPORTS

These reports are preliminary, and the figures are subject to change when later returns are received by the State health officers

Reports for Week Ended May 22, 1926

ALABAMA	Cases
Chicken pox	39
Diphtheria	14
Influenza	20
Lethargic encephalitis	1
Malaria	23
Measles	371
Mumps	32
Pellagra	26
Pneumonia	51
Poliomyelitis	2
Scarlet fever	12
Smallpox	28
Tetanus	3
Tuberculosis	186
Typhoid fever	9
Typhus fever	1
Whooping cough	63

ARIZONA	
Chicken pox	1
Diphtheria	3
Influenza	2
Measles	9
Mumps	3
Pneumonia	1
Scarlet fever	3
Trachoma	18
Tuberculosis	17
Typhoid fever	8
Whooping cough	4

ARKANSAS	
Chicken pox	48
Hookworm disease	2
Influenza	36
Malaria	26
Measles	64
Mumps	32
Ophthalmia neonatorum	3
Pellagra	19
Scarlet fever	20

ARKANSAS—continued	Cases
Smallpox	17
Trachoma	2
Tuberculosis	6
Typhoid fever	6
Whooping cough	44

CALIFORNIA	
Cerebrospinal meningitis:	
Los Angeles	1
Los Angeles County	1
San Francisco	1
Chicken pox	195
Diphtheria	113
Influenza	10
Measles	496
Mumps	309
Poliomyelitis:	
San Diego County	1
Stanislaus County	1
Scarlet fever	139
Smallpox:	
Los Angeles	10
Scattering	28
Typhoid fever	24
Whooping cough	76

COLORADO	
Chicken pox	56
Diphtheria	24
German measles	5
Measles	96
Mumps	7
Pneumonia	6
Puerperal septicemia	1
Scarlet fever	33
Septic sore throat	1
Smallpox	3
Tuberculosis	27
Typhoid fever	2
Vincent's angina	1
Whooping cough	8

CONNECTICUT

	Cases
Cerebrospinal meningitis	2
Chicken pox	66
Conjunctivitis (infectious)	1
Diphtheria	27
German measles	23
Influenza	4
Measles	471
Mumps	12
Pneumonia (broncho)	39
Pneumonia (lobar)	32
Scarlet fever	81
Septic sore throat	1
Tuberculosis (all forms)	51
Typhoid fever	9
Whooping cough	62

DELAWARE

Diphtheria	3
Measles	53
Pneumonia	2
Scarlet fever	4
Whooping cough	2

DISTRICT OF COLUMBIA

Chicken pox	28
Diphtheria	12
Influenza	1
Lethargic encephalitis	2
Measles	353
Pneumonia	33
Scarlet fever	39
Tuberculosis	24
Typhoid fever	2
Whooping cough	52

FLORIDA

Cerebrospinal meningitis	1
Chicken pox	30
Diphtheria	11
German measles	7
Influenza	1
Malaria	4
Measles	84
Mumps	14
Pneumonia	3
Scarlet fever	6
Smallpox	65
Tuberculosis	17
Typhoid fever	9
Whooping cough	21

GEORGIA

Cerebrospinal meningitis	2
Chicken pox	27
Conjunctivitis (acute)	2
Diphtheria	9
Dysentery	23
Hookworm disease	3
Influenza	16
Malaria	42
Measles	95
Mumps	34
Paratyphoid fever	1
Pellagra	12

GEORGIA—continued

	Cases
Pneumonia	31
Scarlet fever	2
Septic sore throat	6
Smallpox	39
Tetanus	1
Tuberculosis	16
Typhoid fever	32
Whooping cough	51

IDAHO

Cerebrospinal meningitis—Wallace	1
Chicken pox	4
Diphtheria	3
Measles	17
Mumps	4
Scarlet fever	9
Smallpox	14
Tuberculosis	8
Typhoid fever	2
Whooping cough	2

ILLINOIS

Cerebrospinal meningitis:	
Douglas County	2
Wayne County	1
Diphtheria	84
Influenza	55
Lethargic encephalitis:	
Cook County	2
Lake County	1
Measles	•1,175
Pneumonia	305
Poliomyelitis—Schuyler County	1
Scarlet fever	327
Smallpox	16
Tuberculosis	473
Typhoid fever	9
Whooping cough	186

INDIANA

Chicken pox	34
Diphtheria	13
Influenza	21
Measles	767
Pneumonia	9
Scarlet fever	93
Smallpox	76
Tuberculosis	66
Typhoid fever	5
Whooping cough	94

IOWA

Chicken pox	11
Diphtheria	15
German measles	105
Measles	89
Mumps	17
Pneumonia	5
Scarlet fever	32
Smallpox	29
Tuberculosis	7
Typhoid fever	2
Whooping cough	9

KANSAS

	Cases
Chicken pox	76
Diphtheria	10
German measles	31
Influenza	5
Measles	667
Mumps	25
Pneumonia	33
Poliomyelitis—Fort Scott	1
Scarlet fever	42
Smallpox:	
Beloit	8
Scattering	17
Tetanus	1
Tuberculosis	38
Whooping cough	123

LOUISIANA

Diphtheria	6
Influenza	23
Malaria	8
Pneumonia	47
Scarlet fever	19
Smallpox	14
Tuberculosis	84
Typhoid fever	8
Whooping cough	11

MAINE

Cerebrospinal meningitis	1
Chicken pox	19
Diphtheria	1
German measles	39
Influenza	21
Measles	191
Mumps	24
Paratyphoid fever	3
Pneumonia	13
Scarlet fever	13
Septic sore throat	1
Tuberculosis	12
Typhoid fever	3
Vincent's angina	10
Whooping cough	38

MARYLAND [1]

Chicken pox	68
Diphtheria	18
Dysentery	2
German measles	3
Influenza	12
Lethargic encephalitis	1
Measles	459
Mumps	191
Ophthalmia neonatorum	1
Paratyphoid fever	1
Pneumonia (broncho)	33
Pneumonia (lobar)	48
Scarlet fever	58
Septic sore throat	1
Tuberculosis	53
Typhoid fever	7
Whooping cough	62

MASSACHUSETTS

Actinomycosis	1
Cerebrospinal meningitis	2

[1] Week ended Friday.

MASSACHUSETTS—continued

	Cases
Chicken pox	131
Conjunctivitis (suppurative)	10
Diphtheria	51
Dysentery	1
German measles	465
Influenza	14
Lethargic encephalitis	1
Measles	828
Mumps	160
Ophthalmia neonatorum	53
Pneumonia (lobar)	86
Poliomyelitis	2
Scarlet fever	247
Septic sore throat	3
Trachoma	1
Tuberculosis (pulmonary)	152
Tuberculosis (other forms)	19
Typhoid fever	7
Whooping cough	243

MICHIGAN

Diphtheria	87
Measles	1,323
Pneumonia	105
Scarlet fever	335
Smallpox	10
Tuberculosis	74
Typhoid fever	6
Whooping cough	132

MINNESOTA

Chicken pox	103
Diphtheria	32
Influenza	2
Measles	740
Pneumonia	5
Scarlet fever	287
Smallpox	11
Tuberculosis	58
Typhoid fever	1
Whooping cough	84

MISSISSIPPI

Cerebrospinal meningitis	1
Diphtheria	3
Scarlet fever	4
Smallpox	7
Typhoid fever	9

MISSOURI

Chicken pox	31
Diphtheria	50
Influenza	6
Malaria	2
Measles	1,251
Mumps	10
Ophthalmia neonatorum	2
Pneumonia	6
Rabies (in animals)	6
Scarlet fever	191
Smallpox	8
Tetanus	1
Tuberculosis	49
Typhoid fever	15
Whooping cough	77

MONTANA

	Cases
Chicken pox	17
Diphtheria	1
German measles	14
Measles	94
Mumps	3
Rocky Mountain spotted fever—Billings	1
Scarlet fever	27
Smallpox	5
Trachoma	1
Tuberculosis	6
Whooping cough	10

NEBRASKA

Chicken pox	44
Diphtheria	3
German measles	6
Influenza	6
Measles	91
Mumps	4
Scarlet fever	100
Smallpox	9
Tuberculosis	6
Typhoid fever	2
Whooping cough	9

NEW JERSEY

Anthrax	2
Cerebrospinal meningitis	4
Chicken pox	207
Diphtheria	85
Influenza	9
Measles	1,672
Pneumonia	179
Scarlet fever	231
Typhoid fever	1
Whooping cough	111

NEW MEXICO

Chicken pox	10
Diphtheria	5
Measles	24
Mumps	3
Pneumonia	4
Rabies (in animals)	1
Scarlet fever	9
Tuberculosis	40
Whooping cough	22

NEW YORK

(Exclusive of New York City)

Cerebrospinal meningitis	2
Chicken pox	241
Diphtheria	74
German measles	561
Influenza	15
Malaria	2
Measles	2,139
Mumps	146
Ophthalmia neonatorum	3
Pneumonia	319
Poliomyelitis	1
Scarlet fever	174
Septic sore throat	2
Smallpox	1
Trachoma	2
Typhoid fever	14
Vincent's angina	8
Whooping cough	318

NORTH CAROLINA

	Cases
Chicken pox	78
Diphtheria	14
German measles	123
Measles	529
Scarlet fever	11
Septic sore throat	2
Smallpox	38
Typhoid fever	4
Whooping cough	272

OKLAHOMA

(Exclusive of Oklahoma City and Tulsa)

Chicken pox	24
Diphtheria	7
Influenza	72
Malaria	33
Measles	93
Mumps	7
Pneumonia	33
Scarlet fever	37
Smallpox	36
Typhoid fever	13
Whooping cough	32

OREGON

Cerebrospinal meningitis	4
Chicken pox	38
Diphtheria	8
Influenza	16
Lethargic encephalitis	1
Measles	82
Mumps	21
Pneumonia	[1] 3
Scarlet fever	47
Septic sore throat	2
Smallpox:	
Portland	14
Scattering	9
Tuberculosis	11
Typhoid fever	4
Whooping cough	23

PENNSYLVANIA

Cerebrospinal meningitis—Pittsburgh	1
Chicken pox	293
Diphtheria	159
German measles	91
Malaria	1
Measles	4,255
Mumps	75
Ophthalmia neonatorum—Philadelphia	3
Pneumonia	51
Poliomyelitis—Philadelphia	1
Scabies	2
Scarlet fever	678
Smallpox	2
Tuberculosis	129
Typhoid fever	9
Whooping cough	397

RHODE ISLAND

Chicken pox	2
Diphtheria	5
German measles	25
Measles	45

[1] Deaths.

RHODE ISLAND—continued

	Cases
Mumps	4
Scarlet fever	7
Septic sore throat	2
Tuberculosis	15
Whooping cough	6

SOUTH DAKOTA

Chicken pox	6
Diphtheria	5
Influenza	3
Measles	9
Mumps	12
Pneumonia	1
Scarlet fever	33
Smallpox	1
Whooping cough	10

TENNESSEE

Cerebrospinal meningitis:	
Lauderdale County	1
Maury County	1
Chicken pox	29
Diphtheria	8
Influenza	52
Lethargic encephalitis—Robertson County	1
Malaria	15
Measles	677
Mumps	11
Pellagra	17
Pneumonia	28
Rabies	1
Scarlet fever	32
Smallpox	20
Trachoma	2
Tuberculosis	33
Typhoid fever	7
Whooping cough	30

TEXAS

Cerebrospinal meningitis	1
Chicken pox	33
Dengue	3
Diphtheria	31
Dysentery	1
Influenza	16
Measles	23
Mumps	16
Pellagra	4
Pneumonia	7
Scarlet fever	13
Smallpox	74
Tuberculosis	15
Typhoid fever	4
Whooping cough	37

UTAH

Chicken pox	31
Diphtheria	8
German measles	10
Measles	41
Mumps	29
Pneumonia	2
Scarlet fever	4

UTAH—continued

	Cases
Typhoid fever	1
Whooping cough	133

VERMONT

Chicken pox	12
Measles	56
Mumps	19
Scarlet fever	8
Whooping cough	12

WASHINGTON

Cerebrospinal meningitis:	
Pierce County	1
Seattle	2
Spokane	4
Tacoma	1
Chicken pox	63
Diphtheria	11
German measles	97
Measles	59
Mumps	40
Scarlet fever	83
Smallpox	23
Tuberculosis	44
Typhoid fever	4
Whooping cough	45

WISCONSIN

Milwaukee:	
Chicken pox	83
Diphtheria	19
German measles	4
Influenza	6
Measles	282
Mumps	45
Pneumonia	42
Scarlet fever	15
Tuberculosis	16
Whooping cough	53
Scattering:	
Chicken pox	80
Diphtheria	24
German measles	107
Influenza	41
Measles	1,043
Mumps	70
Pneumonia	45
Scarlet fever	91
Smallpox	4
Tuberculosis	19
Typhoid fever	4
Whooping cough	117

WYOMING

Chicken pox	15
German measles	18
Influenza	2
Measles	6
Mumps	8
Pneumonia	1
Rocky Mountain spotted fever:	
Johnson County	1
Platte County	1
Sweetwater County	2
Scarlet fever	22
Whooping cough	5

Reports for Week Ended May 15, 1926

CONNECTICUT	Cases
Cerebrospinal meningitis	1
Chicken pox	63
Diphtheria	16
Dysentery (bacillary)	1
German measles	43
Influenza	12
Lethargic encephalitis	1
Measles	522
Mumps	9
Pneumonia (broncho)	49
Pneumonia (lobar)	49
Scarlet fever	95
Tuberculosis (pulmonary)	31
Whooping cough	54
DISTRICT OF COLUMBIA	
Chicken pox	22
Diphtheria	15
Influenza	1
Measles	427
Pneumonia	39
Scarlet fever	36
Tuberculosis	19
Whooping cough	33
MISSISSIPPI	
Diphtheria	2
Scarlet fever	2
MISSISSIPPI—continued	
Smallpox	9
Typhoid fever	9
MISSOURI	
Cerebrospinal meningitis	1
Chicken pox	43
Diphtheria	68
Influenza	3
Measles	1,531
Mumps	24
Pneumonia	2
Rabies (in animals)	7
Scarlet fever	220
Smallpox	9
Tuberculosis	25
Typhoid fever	3
Whooping cough	81
WEST VIRGINIA	
Cerebrospinal meningitis—Cabell County	1
Chicken pox	21
Diphtheria	15
Influenza	20
Measles	817
Scarlet fever	35
Tuberculosis	36
Typhoid fever	16
Whooping cough	23

SUMMARY OF MONTHLY REPORTS FROM STATES

The following summary of monthly State reports is published weekly and covers only those States from which reports are received during the current week:

State	Cerebrospinal meningitis	Diphtheria	Influenza	Malaria	Measles	Pellagra	Poliomyelitis	Scarlet fever	Smallpox	Typhoid fever
March, 1926										
California	16	619	425	7	780	1	13	815	745	41
April, 1926										
Delaware	1	10	4	1	289		0	39	0	1
Louisiana	5	31	202	49	93	14	0	98	105	48
Massachusetts	13	228	625	2	3,776	1	5	1,103	4	23
Missouri	3	220	415	15	3,799		0	1,007	38	24
New Jersey	10	259	176	1	9,914		1	800	1	28
North Dakota	0	38	159		614		0	385	12	12
Wisconsin	10	162	2,605	0	3,930	0	1	796	27	12
Wyoming	1	7	4	0	12	0	0	138	2	0

RECIPROCAL NOTIFICATIONS

Notifications regarding communicable diseases sent during the month of April, 1926, to other State health departments by departments of health of certain States

Referred by—	Diphtheria	German measles	Measles	Mumps	Scarlet fever	Smallpox	Tuberculosis	Typhoid fever
Illinois		1	1	1		5		
Minnesota	1						37	1
New Jersey					1			
New York			6		2	1		3
Ohio			2					

PLAGUE ERADICATIVE MEASURES IN LOS ANGELES, CALIF.

The following items were taken from the report of plague eradicative measures from Los Angeles, Calif.:

Week ended May 15, 1926:

Number of rats trapped	617
Number of rats found to be plague infected	0
Number of squirrels examined	646
Number of squirrels found to be plague infected	0
Number of mice trapped	607
Number of mice found to be plague infected	0

Date of discovery of last plague-infected rodent, Nov. 6, 1925.
Date of last human case, Jan. 15, 1925.

GENERAL CURRENT SUMMARY AND WEEKLY REPORTS FROM CITIES

Diphtheria.—For the week ended May 8, 1926, 36 States reported 1,049 cases of diphtheria. For the week ended May 9, 1925, the same States reported 1,243 cases of this disease. Ninety-nine cities, situated in all parts of the country and having an aggregate population of more than 30,100,000, reported 660 cases of diphtheria for the week ended May 8, 1926. Last year for the corresponding week they reported 866 cases. The estimated expectancy for these cities was 888 cases. The estimated expectancy is based on the experience of the last nine years, excluding epidemics.

Measles.—Thirty-four States reported 19,821 cases of measles for the week ended May 8, 1926, and 5,660 cases of this disease for the week ended May 9, 1925. Ninety-nine cities reported 9,923 cases of measles for the week this year, and 3,444 cases last year.

Poliomyelitis.—The health officers of 37 States reported 11 cases of poliomyelitis for the week ended May 8, 1926. The same States reported 16 cases for the week ended May 9, 1925.

Scarlet fever.—Scarlet fever was reported for the week as follows: Thirty-six States—this year, 3,461 cases; last year, 3,446 cases; 99 cities—this year, 1,697 cases; last year, 1,780 cases; estimated expectancy, 1,103 cases.

Smallpox.—For the week ended May 8, 1926, 37 States reported 732 cases of smallpox. Last year for the corresponding week they reported 791 cases. Ninety-nine cities reported smallpox for the week as follows: 1926, 151 cases; 1925, 248 cases; estimated expectancy, 112 cases. Seven deaths from smallpox were reported by these cities for the week this year—1 at Chicago, Ill., 5 at Los Angeles, Calif., and 1 at San Francisco, Calif.

Typhoid fever.—One hundred and seventy-eight cases of typhoid fever were reported for the week ended May 8, 1926, by 36 States. For the corresponding week of 1925, the same States reported 248 cases of this disease. Ninety-nine cities reported 41 cases of typhoid

fever for the week this year and 75 cases for the corresponding week last year. The estimated expectancy for these cities was 66 cases.

Influenza and pneumonia.—Deaths from influenza and pneumonia were reported for the week by 94 cities, with a population of more than 29,500,000, as follows: 1926, 1,064 deaths; 1925, 887.

City reports for week ended May 8, 1926

The "estimated expectancy" given for diphtheria, poliomyelitis, scarlet fever, smallpox, and typhoid fever is the result of an attempt to ascertain from previous occurrence how many cases of the disease under consideration may be expected to occur during a certain week in the absence of epidemics. It is based on reports to the Public Health Service during the past nine years. It is in most instances the median number of cases reported in the corresponding week of the preceding years. When the reports include several epidemics or when for other reasons the median is unsatisfactory, the epidemic periods are excluded and the estimated expectancy is the mean number of cases reported for the week during nonepidemic years.

If reports have not been received for the full nine years, data are used for as many years as possible, but no year earlier than 1917 is included. In obtaining the estimated expectancy, the figures are smoothed when necessary to avoid abrupt deviations from the usual trend. For some of the diseases given in the table the available data were not sufficient to make it practicable to compute the estimated expectancy.

Division, State, and city	Population July 1, 1925, estimated	Chicken pox, cases reported	Diphtheria		Influenza		Measles, cases reported	Mumps, cases reported	Pneumonia, deaths reported
			Cases, estimated expectancy	Cases reported	Cases reported	Deaths reported			
NEW ENGLAND									
Maine:									
Portland	75,333	0	1	0	1	0	267	7	4
New Hampshire:									
Concord	22,546	0	0	0	0	0	1	0	2
Vermont:									
Barre	10,008	0	0	0	0	0	0	2	0
Massachusetts:									
Boston	779,620	19	52	21	8	1	166	61	36
Fall River	128,993	2	3	2	0	0	6	1	2
Springfield	142,065	2	3	0	2	1	32	1	3
Worcester	190,757	7	3	10	8	0	12	0	6
Rhode Island:									
Pawtucket	69,760	1	1	1	0	0	33	0	3
Providence	267,918	0	10	5	0	2	62	0	3
Connecticut:									
Bridgeport	(1)	0	4	4	2	2	5	1	4
Hartford	160,197	3	6	2	1	0	25	0	4
New Haven	178,927	19	3	0	1	0	116	0	5
MIDDLE ATLANTIC									
New York:									
Buffalo	538,016	15	10	7	0	1	25	0	13
New York	5,873,356	144	256	130	53	25	1,345	84	217
Rochester	316,786	5	7	19	0	0	114	2	5
Syracuse	182,003	2	6	1	1	1	215	35	6
New Jersey:									
Camden	128,642	2	4	4	0	0	23	1	4
Newark	452,513	43	15	13	4	0	263	10	10
Trenton	132,020	7	3	2	2	1	76	0	6
Pennsylvania:									
Philadelphia	1,979,364	60	67	68	----	9	603	12	61
Pittsburgh	631,563	7	16	7	----	8	188	2	26
Reading	112,707	9	3	1	----	0	20	1	2
EAST NORTH CENTRAL									
Ohio:									
Cincinnati	409,333	11	5	11	1	6	303	12	15
Cleveland	936,485	27	21	21	5	6	82	8	21
Columbus	279,836	1	3	4	0	5	191	2	6
Toledo	287,380	0	4	0	0	4	0	0	10

[1] No estimate made.

City reports for week ended May 8, 1926—Continued

Division, State, and city	Population July 1, 1925, estimated	Chicken pox, cases reported	Diphtheria		Influenza		Measles, cases reported	Mumps, cases reported	Pneumonia, deaths reported
			Cases, estimated expectancy	Cases reported	Cases reported	Deaths reported			
EAST NORTH CENTRAL—continued									
Indiana:									
Fort Wayne	97,846	5	2	0	0	0	76	0	6
Indianapolis	358,819	6	5	0	0	0	115	0	17
South Bend	80,091	3	1	0	0	0	30	0	2
Terre Haute	71,071	0	0	0	0	0	31	0	0
Illinois:									
Chicago	2,995,239	90	92	35	16	6	190	24	93
Peoria	81,564	1	0	0	0	0	54	1	1
Springfield	63,923	1	1	0	1	2	55	6	0
Michigan:									
Detroit	1,245,824	14	43	45	2	12	176	6	68
Flint	130,316	3	3	0	0	0	131	1	5
Grand Rapids	153,698	4	4	3	0	2	43	0	5
Wisconsin:									
Kenosha	50,891	10	1	1	1	0	4	0	1
Madison	46,385	1	0	1	0	0	234	0	1
Milwaukee	509,192	39	11	11	3	2	270	39	20
Racine	67,707	3	1	0	1	1	128	12	2
Superior	39,671	0	0	0	0	0	79	0	0
WEST NORTH CENTRAL									
Minnesota:									
Duluth	110,502	10	2	0	0	0	48	0	5
Minneapolis	425,435	68	16	25	0	2	216	1	12
St. Paul	246,001	33	15	9	0	0	217	8	15
Iowa:									
Davenport	52,469	1	1	1	0	-------	5	0	-------
Sioux City	76,411	2	1	0	0	-------	0	0	-------
Waterloo	36,771	2	1	1	0	-------	55	0	-------
Missouri:									
Kansas City	367,481	10	6	1	4	4	249	5	6
St. Joseph	78,342	1	1	2	0	0	46	1	4
St. Louis	821,543	23	39	55	2	0	1,166	10	-------
North Dakota:									
Fargo	26,403	3	0	5	0	0	0	8	1
Grand Forks	14,811	-------	0	-------	-------	-------	-------	-------	-------
South Dakota:									
Aberdeen	15,036	8	0	1	0	-------	48	29	-------
Sioux Falls	30,127	2	0	0	0	0	3	0	0
Nebraska:									
Lincoln	60,941	8	2	0	0	1	0	2	1
Omaha	211,768	10	3	0	0	0	133	0	12
Kansas:									
Topeka	55,411	26	0	0	0	0	12	0	3
Wichita	88,367	9	1	0	0	0	95	0	0
SOUTH ATLANTIC									
Delaware:									
Wilmington	122,049	0	1	3	0	0	13	0	2
Maryland:									
Baltimore	796,296	46	22	8	7	4	138	250	34
Cumberland	33,741	0	0	0	0	0	20	0	1
Frederick	12,035	0	0	0	0	0	1	0	0
District of Columbia:									
Washington	497,906	14	10	22	0	1	484	0	19
Virginia:									
Lynchburg	30,395	10	0	2	0	0	67	0	2
Norfolk	(1)	43	0	0	0	0	7	0	2
Richmond	186,403	7	2	0	0	1	44	14	2
Roanoke	58,208	0	0	0	0	0	69	1	6
West Virginia:									
Charleston	49,019	3	0	0	2	2	10	0	0
Huntington	63,485	0	0	0	0	0	0	0	0
Wheeling	56,208	6	1	0	0	1	133	0	3
North Carolina:									
Raleigh	30,371	1	0	1	0	0	0	0	1
Wilmington	37,061	11	1	0	0	0	2	1	2
Winston-Salem	69,031	7	1	1	0	0	7	16	1

[1] No estimate made.

City reports for week ended May 8, 1926—Continued

Division, State, and city	Population July 1, 1925, estimated	Chicken pox, cases reported	Diphtheria		Influenza		Measles, cases reported	Mumps, cases reported	Pneumonia, deaths reported
			Cases, estimated expectancy	Cases reported	Cases reported	Deaths reported			
SOUTH ATLANTIC—con.									
South Carolina:									
Charleston	73,125	4	0	0	23	0	14	1	2
Columbia	41,225	8	0	0	0	0	0	1	0
Greenville	27,311	0	0	0	0	0	0	3	0
Georgia:									
Atlanta	(1)	3	1	2	6	0	17	1	7
Brunswick	16,809	1	0	0	0	0	0	0	0
Savannah	93,134	4	0	0	5	1	6	1	5
Florida:									
St. Petersburg	26,847		0			0			1
Tampa	94,743	4	0	1	0	0	2	3	1
EAST SOUTH CENTRAL									
Kentucky:									
Covington	58,309	3	1	2	0	0	22	0	4
Louisville	305,935	6	4	2	0	1	174	0	15
Tennessee:									
Memphis	174,533	24	3	5	0	6	301	37	5
Nashville	136,220	0	1	0	0	8	18	0	5
Alabama:									
Birmingham	205,670	11	2	3	6	4	108	3	14
Mobile	65,955	1	0	0	1	0	0	0	0
Montgomery	46,481	2	0	0	0	0	3	8	0
WEST SOUTH CENTRAL									
Arkansas:									
Fort Smith	31,643	1	0	0	0		0	4	
Little Rock	74,216	4	0	0	0	0	20	0	2
Louisiana:									
New Orleans	414,493	2	7	8	7	7	5	0	9
Shreveport	57,857	3	1	0	0	0	0	14	3
Oklahoma:									
Oklahoma City	(1)	0	0	0	4	0	2	0	3
Tulsa	124,478	22	1	0	0		33	27	
Texas:									
Dallas	194,450	24	3	6	0	0	0	1	3
Galveston	48,375	0	0	0	0	0	1	0	1
Houston	164,954	0	2	0	0	1	1	1	4
San Antonio	198,069	2	1	0	0	2	2	0	3
MOUNTAIN									
Montana:									
Billings	17,971	3	0	0		0	0	3	0
Great Falls	29,883	21	1	0	0	0	50	0	0
Helena	12,037	0	0	0	0	0	2	0	0
Missoula	12,668	0	0	0	0	0	2	1	0
Idaho:									
Boise	23,042	0	0	0	0	0	0	1	0
Colorado:									
Denver	280,911	32	11	11		2	23	2	5
Pueblo	43,787	16	1	3	0	0	7	0	3
New Mexico:									
Albuquerque	21,000	3	1	0	0	0	3	10	0
Arizona:									
Phoenix	38,669	0	0	0	0	0	1	0	1
Utah:									
Salt Lake City	130,948	24	3	2	0	0	13	7	1
Nevada:									
Reno	12,665	0	0	0	0	0	0	0	0
PACIFIC									
Washington:									
Seattle	(1)	19	5	4	0		50	19	
Spokane	108,897	8	2	4	0		0	0	
Tacoma	104,455		1						
Oregon:									
Portland	282,383	30	5	6	0	0	46	10	2
California:									
Los Angeles	(1)	36	33	33	8	0	10	16	16
Sacramento	72,260	7	1	2	0	0	0	0	1
San Francisco	557,530	37	21	15	2	1	182	22	5

[1] No estimate made.

City reports for week ended May 8, 1926—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths, all causes
	Cases, estimated expectancy	Cases reported	Cases, estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
NEW ENGLAND											
Maine:											
Portland	2	6	0	0	0	1	0	1	0	9	21
New Hampshire:											
Concord	0	4	0	0	0	1	0	0	0	0	11
Vermont:											
Barre	0	0	0	0	0	0	0	0	0	0	4
Massachusetts:											
Boston	55	47	0	0	0	19	2	1	0	88	272
Fall River	4	2	0	0	0	4	1	0	0	0	26
Springfield	6	2	0	0	0	2	0	0	0	8	36
Worcester	8	8	0	0	0	5	0	0	0	20	----
Rhode Island:											
Pawtucket	1	2	0	0	0	1	0	0	0	5	21
Providence	10	1	0	0	0	8	0	1	0	12	75
Connecticut:											
Bridgeport	6	14	0	0	0	1	0	0	0	2	37
Hartford	5	2	0	0	0	3	0	1	0	2	25
New Haven	6	6	0	0	0	1	1	0	0	23	44
MIDDLE ATLANTIC											
New York:											
Buffalo	18	0	0	0	0	12	0	2	0	21	145
New York	265	228	0	0	0	[1] 129	11	6	0	67	1,525
Rochester	16	12	0	0	0	4	0	0	0	14	79
Syracuse	12	5	0	0	0	6	1	1	0	57	62
New Jersey:											
Camden	3	14	0	0	0	1	0	0	0	0	31
Newark	21	21	0	0	0	14	0	0	0	24	110
Trenton	2	6	0	0	0	4	0	3	0	1	40
Pennsylvania:											
Philadelphia	76	99	1	0	0	43	5	2	0	31	577
Pittsburgh	24	45	0	0	0	15	1	0	0	90	210
Reading	3	6	0	0	0	1	1	0	0	9	28
EAST NORTH CENTRAL											
Ohio:											
Cincinnati	14	26	2	6	0	7	1	1	0	41	137
Cleveland	22	77	1	0	0	15	2	0	0	98	217
Columbus	8	12	2	2	0	5	0	1	1	5	73
Toledo	14	0	5	0	0	3	1	0	0	0	75
Indiana:											
Fort Wayne	3	10	2	0	0	1	1	0	0	4	31
Indianapolis	13	3	7	18	0	5	1	0	1	55	95
South Bend	3	5	1	1	0	2	0	0	0	17	15
Terre Haute	3	4	2	0	0	0	0	0	0	3	----
Illinois:											
Chicago	114	127	2	5	1	61	3	3	0	41	803
Peoria	3	4	0	1	0	1	0	0	0	6	19
Springfield	2	3	0	0	0	0	0	0	0	8	22
Michigan:											
Detroit	77	134	3	0	0	15	3	0	0	75	390
Flint	6	9	1	0	0	0	0	0	0	6	27
Grand Rapids	7	18	1	0	0	4	1	0	0	18	48
Wisconsin:											
Kenosha	2	2	1	0	0	0	0	0	0	3	6
Madison	3	3	0	0	0	2	0	0	0	2	9
Milwaukee	26	14	4	0	0	11	0	1	1	30	145
Racine	4	3	1	0	0	0	0	0	0	21	9
Superior	2	7	1	0	0	2	0	0	0	0	7
WEST NORTH CENTRAL											
Minnesota:											
Duluth	4	25	1	1	0	3	0	1	0	7	20
Minneapolis	29	85	8	0	0	9	0	0	0	9	125
St. Paul	21	50	4	0	0	4	0	0	0	34	71

[1] Pulmonary tuberculosis only.

City reports for week ended May 8, 1926—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths, all causes
	Cases, estimated expectancy	Cases reported	Cases, estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
WEST NORTH CENTRAL—continued											
Iowa:											
Davenport	1	6	4	0	----	----	0	0	----	0	----
Sioux City	3	3	1	16	----	----	0	0	----	0	----
Waterloo	1	2	0	0	----	----	0	0	----	4	----
Missouri:											
Kansas City	9	27	2	0	0	6	1	0	0	18	96
St. Joseph	2	4	1	0	0	3	0	0	0	0	34
St. Louis	31	169	4	2	0	5	2	1	0	40	230
North Dakota:											
Fargo	1	5	0	0	0	1	0	0	0	0	7
Grand Forks	0	----	0	----	----	----	0	----	----	----	----
South Dakota:											
Aberdeen	1	10	0	0	----	----	0	0	----	26	----
Sioux Falls	1	3	1	0	0	0	0	0	0	0	5
Nebraska:											
Lincoln	2	1	1	2	0	1	0	0	0	11	15
Omaha	4	85	7	10	0	10	0	0	0	8	68
Kansas:											
Topeka	3	9	1	0	0	1	1	0	0	9	18
Wichita	2	2	3	0	0	0	0	1	0	11	31
SOUTH ATLANTIC											
Delaware:											
Wilmington	4	6	0	0	0	1	1	1	0	0	24
Maryland:											
Baltimore	28	44	1	0	0	20	2	0	0	61	245
Cumberland	1	0	0	0	0	1	0	0	0	2	9
Frederick	1	0	0	0	0	0	0	0	0	0	4
District of Col.:											
Washington	22	22	1	1	0	13	1	1	0	33	155
Virginia:											
Lynchburg	1	2	0	0	0	1	1	0	0	10	15
Norfolk	1	8	0	0	0	2	0	0	0	16	----
Richmond	2	7	1	0	5	1	1	0	0	0	49
Roanoke	0	1	1	1	0	1	0	0	0	0	18
West Virginia:											
Charleston	1	0	0	0	0	0	0	0	0	0	10
Huntington	1	3	0	0	0	0	0	0	0	0	----
Wheeling	2	2	0	0	0	0	1	1	2	1	16
North Carolina:											
Raleigh	0	0	0	0	0	1	0	0	0	13	10
Wilmington	0	0	0	0	0	0	0	0	0	5	11
Winston-Salem	1	0	5	5	0	1	1	0	0	18	23
South Carolina:											
Charleston	0	0	0	1	0	0	1	2	1	2	30
Columbia	0	0	1	0	0	0	1	0	0	0	----
Greenville	0	0	0	1	0	1	0	0	0	3	10
Georgia:											
Atlanta	3	1	4	2	0	3	0	0	0	6	58
Brunswick	0	0	0	0	0	0	0	0	0	0	0
Savannah	1	0	1	0	0	1	1	0	0	0	28
Florida:											
St. Petersburg	0	----	0	----	0	2	0	----	0	----	23
Tampa	0	1	0	5	0	3	1	2	0	1	29
EAST SOUTH CENTRAL											
Kentucky:											
Covington	1	0	1	3	0	2	1	0	0	0	31
Louisville	5	3	1	1	0	7	1	1	0	7	88
Tennessee:											
Memphis	4	28	2	6	0	3	1	1	0	4	65
Nashville	2	2	1	0	0	7	1	0	0	6	52
Alabama:											
Birmingham	1	2	7	1	0	5	1	0	0	11	82
Mobile	0	0	1	0	0	3	0	1	0	0	13
Montgomery	0	1	0	3	0	0	0	0	0	0	25
WEST SOUTH CENTRAL											
Arkansas:											
Fort Smith	0	0	0	0	----	----	0	0	----	3	----
Little Rock	0	7	0	0	0	1	1	0	0	3	----

City reports for week ended May 8, 1926—Continued

Division, State, and city	Scarlet fever		Smallpox			Tuberculosis, deaths reported	Typhoid fever			Whooping cough, cases reported	Deaths, all causes
	Cases, estimated expectancy	Cases reported	Cases, estimated expectancy	Cases reported	Deaths reported		Cases, estimated expectancy	Cases reported	Deaths reported		
WEST SOUTH CENTRAL—continued											
Louisiana:											
New Orleans	4	22	2	4	0	17	3	2	1	2	159
Shreveport	0	0	2	1	0	4	1	2	1	1	33
Oklahoma:											
Oklahoma City	1	3	4	1	0	3	0	0	0	0	26
Tulsa	1	2	2	1	----	----	0	0	----	20	----
Texas:											
Dallas	2	7	2	10	0	4	0	0	0	14	56
Galveston	0	1	0	7	0	1	0	0	0	0	13
Houston	1	3	1	15	0	2	0	0	0	0	40
San Antonio	1	1	0	0	0	7	1	0	0	0	62
MOUNTAIN											
Montana:											
Billings	0	2	0	0	0	0	0	0	0	0	7
Great Falls	1	2	2	0	0	0	0	0	0	13	4
Helena	0	0	0	0	0	0	0	0	0	0	3
Missoula	1	2	0	0	0	0	0	0	0	0	0
Idaho:											
Boise	1	1	0	2	0	0	0	0	0	0	3
Colorado:											
Denver	12	8	2	0	0	13	0	0	0	56	65
Pueblo	1	0	0	0	0	2	0	0	0	2	14
New Mexico:											
Albuquerque	1	9	0	0	0	7	0	0	0	8	14
Arizona:											
Phoenix	1	3	0	0	0	11	0	0	0	0	25
Utah:											
Salt Lake City	2	0	0	2	0	3	0	0	0	73	36
Nevada:											
Reno	0	0	0	0	0	0	0	0	0	0	2
PACIFIC											
Washington:											
Seattle	8	8	3	0	----	----	1	0	----	6	----
Spokane	3	6	5	0	----	----	1	0	----	21	----
Tacoma	3	----	1	----	----	----	0	----	----	----	----
Oregon:											
Portland	7	21	9	2	0	4	0	0	1	1	52
California:											
Los Angeles	16	30	3	17	5	36	2	2	0	4	241
Sacramento	2	2	0	1	0	1	0	1	1	0	12
San Francisco	12	23	3	1	1	8	1	0	0	6	144

Division, State, and city	Cerebrospinal meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)		
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases, estimated expectancy	Cases	Deaths
NEW ENGLAND									
Maine:									
Portland	1	1	0	0	0	0	0	0	0
Massachusetts:									
Boston	0	0	1	0	0	0	1	0	0
Rhode Island:									
Providence	0	0	0	1	0	0	0	0	0
MIDDLE ATLANTIC									
New York:									
New York	4	6	10	9	0	0	1	2	1
Pennsylvania:									
Philadelphia	0	1	2	1	0	0	0	0	0
Pittsburgh	2	0	0	0	0	0	0	0	0

City reports for week ended May 8, 1926—Continued

Division, State, and city	Cerebrospinal meningitis		Lethargic encephalitis		Pellagra		Poliomyelitis (infantile paralysis)		
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases, estimated expectancy	Cases	Deaths
EAST NORTH CENTRAL									
Illinois:									
Chicago	3	2	0	0	1	0	1	0	0
Michigan:									
Detroit	2	0	4	1	0	0	0	0	0
Grand Rapids	0	0	0	1	0	0	0	0	0
WEST NORTH CENTRAL									
Missouri:									
Kansas City	0	0	1	1	0	0	0	0	0
SOUTH ATLANTIC [1]									
North Carolina:									
Raleigh	0	0	0	0	0	1	0	0	0
Wilmington	0	0	0	0	0	1	0	0	0
Winston-Salem	0	0	0	0	0	2	0	0	0
South Carolina:									
Charleston	0	0	0	0	0	1	0	0	0
Georgia:									
Atlanta	0	0	0	0	0	1	0	0	0
Florida:									
Tampa	1	0	0	0	0	0	0	0	0
EAST SOUTH CENTRAL									
Alabama:									
Birmingham	1	0	0	0	0	1	0	0	0
WEST SOUTH CENTRAL									
Texas:									
Houston	0	0	0	0	0	1	0	0	0
MOUNTAIN									
Montana:									
Missoula	1	0	0	0	0	0	0	0	0
Colorado:									
Denver	1	1	0	0	0	0	0	0	0
PACIFIC									
Washington:									
Spokane	3	0	0	0	0	0	0	0	0
Oregon:									
Portland	0	0	0	1	0	0	0	0	0
California:									
Los Angeles	1	2	1	1	1	2	0	0	0
Sacramento	0	1	0	0	0	0	0	0	0
San Francisco	0	0	0	0	0	2	0	0	0

[1] Typhus fever, 1 case at Baltimore, Md.

The following table gives the rates per 100,000 population for 103 cities for the five-week period ended May 8, 1926, compared with those for a like period ended May 9, 1925. The population figures used in computing the rates are approximate estimates as of July 1, 1925 and 1926, respectively, authoritative figures for many of the cities not being available. The 103 cities reporting cases had an estimated aggregated population of nearly 30,000,000 in 1925 and nearly 30,500,000 in 1926. The 96 cities reporting deaths had more than 29,250,000 estimated population in 1925 and more than 29,750,000 in 1926. The number of cities included in each group and the estimated aggregate populations are shown in a separate table below.

Summary of weekly reports from cities, April 4 to May 8, 1926—Annual rates per 100,000 population—Compared with rates for the corresponding period of 1925 [1]

DIPHTHERIA CASE RATES

	Week ended—									
	Apr. 11, 1925	Apr. 10, 1926	Apr. 18, 1925	Apr. 17, 1926	Apr. 25, 1925	Apr. 24, 1926	May 2, 1925	May 1, 1926	May 9, 1925	May 8, 1926
103 cities	152	[2] 117	155	110	155	118	152	[3] 109	[4] 152	[5] 115
New England	161	125	125	47	139	73	122	[3] 75	105	106
Middle Atlantic	219	125	227	118	217	162	212	114	211	[6] 126
East North Central	91	88	103	86	106	87	102	97	106	89
West North Central	219	200	163	241	181	178	195	200	269	[7] 195
South Atlantic	69	86	96	90	102	68	98	68	98	75
East South Central	32	[3] 121	42	47	37	26	37	73	11	62
West South Central	101	60	70	30	75	47	66	56	62	60
Mountain	102	118	231	191	259	82	111	118	102	146
Pacific	163	137	160	135	157	146	196	154	[4] 117	[8] 165

MEASLES CASE RATES

103 cities	510	[2] 1,784	564	1,769	620	1,790	559	[2] 1,717	[4] 603	[5] 1,712
New England	975	1,572	884	1,813	1,174	1,666	968	[2] 1,675	949	1,714
Middle Atlantic	677	1,769	811	1,699	779	1,593	731	1,417	793	[6] 1,410
East North Central	658	1,570	681	1,469	833	1,457	706	1,486	830	1,454
West North Central	56	3,240	88	3,309	98	4,079	76	3,988	109	[7] 4,458
South Atlantic	196	2,652	242	2,943	278	2,538	288	2,598	227	1,942
East South Central	32	[3] 3,218	89	2,781	173	3,445	184	2,885	315	3,248
West South Central	48	237	62	133	35	163	26	159	31	125
Mountain	55	419	259	528	213	1,074	518	865	176	883
Pacific	229	391	146	375	193	504	155	669	[4] 91	[8] 690

SCARLET FEVER CASE RATES

103 cities	353	[2] 274	329	307	348	283	297	[3] 293	[4] 311	[5] 294
New England	510	319	338	373	393	222	415	[3] 287	400	222
Middle Atlantic	358	176	341	187	335	201	322	221	318	[6] 217
East North Central	391	330	376	343	410	287	302	289	341	310
West North Central	627	833	631	895	671	883	502	867	599	[7] 933
South Atlantic	144	147	157	182	165	160	125	218	100	177
East South Central	257	[2] 176	210	156	236	228	242	171	242	187
West South Central	84	116	57	133	114	172	106	146	84	176
Mountain	250	100	305	173	388	209	324	218	268	137
Pacific	166	156	138	340	141	262	119	205	[4] 144	[8] 197

SMALLPOX CASE RATES

103 cities	49	[2] 33	46	26	60	31	48	[2] 27	[4] 45	[5] 26
New England	2	0	0	0	2	0	0	[3] 0	2	0
Middle Atlantic	10	0	18	0	12	0	8	0	6	[6] 0
East North Central	21	18	25	14	37	22	29	19	41	22
West North Central	94	51	82	44	86	44	72	32	58	[7] 58
South Atlantic	40	68	50	43	75	47	60	28	42	30
East South Central	525	[2] 94	362	52	420	99	399	99	347	73
West South Central	48	133	13	95	40	112	31	146	26	159
Mountain	18	27	9	27	28	46	9	36	46	36
Pacific	141	137	155	137	251	140	196	102	[4] 167	[8] 54

[1] The figures given in this table are rates per 100,000 population, annual basis, and not the number of cases reported. Populations used are estimated as of July 1, 1925 and 1926, respectively.
[2] Covington, Ky., not included.
[3] Worcester, Mass., not included.
[4] Spokane, Wash., not included.
[5] Trenton, N. J., Grand Forks, N. Dak., and Tacoma, Wash., not included.
[6] Trenton, N. J., not included.
[7] Grand Forks, N. Dak., not included.
[8] Tacoma, Wash., not included.

Summary of weekly reports from cities, April 4 to May 8, 1926—Annual rates per 100,000 population—Compared with rates for the corresponding period of 1925—Continued

TYPHOID FEVER CASE RATES

	Week ended—									
	Apr. 11, 1925	Apr. 10, 1926	Apr. 18, 1925	Apr. 17, 1926	Apr. 25, 1925	Apr. 24, 1926	May 2, 1925	May 1, 1926	May 9, 1925	May 8, 1926
103 cities	9	[2]7	11	7	16	8	17	[3]9	[4]13	[5]7
New England	2	9	7	9	17	5	10	[3]5	5	9
Middle Atlantic	9	5	11	7	14	8	22	6	13	[6]6
East North Central	6	3	4	2	6	1	4	4	8	4
West North Central	2	10	2	4	6	6	12	6	2	[7]6
South Atlantic	19	6	12	4	13	8	27	19	27	13
East South Central	16	[3]11	32	0	74	26	42	21	42	16
West South Central	35	17	53	34	48	26	48	17	44	17
Mountain	18	18	37	9	28	0	0	18	0	0
Pacific	8	13	11	13	22	22	17	27	[4]9	[8]9

INFLUENZA DEATH RATES

96 cities	26	74	26	53	29	38	21	[3]33	14	[9]25
New England	31	83	26	52	29	40	19	[3]39	10	14
Middle Atlantic	16	76	24	59	17	34	14	27	10	[6]22
East North Central	25	81	23	67	31	42	21	46	15	29
West North Central	36	31	49	23	47	31	30	17	11	13
South Atlantic	25	58	10	43	40	30	25	28	19	19
East South Central	68	239	74	47	79	104	47	99	47	99
West South Central	44	71	10	57	24	66	29	28	15	47
Mountain	83	46	37	46	74	46	46	9	18	18
Pacific	11	14	25	21	11	4	11	11	15	[8]4

PNEUMONIA DEATH RATES

96 cities	194	277	184	241	196	201	160	[3]176	145	[9]163
New England	204	359	199	303	180	234	144	[3]194	156	170
Middle Atlantic	189	338	203	288	222	240	206	219	184	[6]173
East North Central	178	245	178	232	199	191	138	152	123	178
West North Central	220	184	165	131	131	136	70	106	74	121
South Atlantic	223	235	217	207	180	205	180	177	148	169
East South Central	315	431	189	332	263	259	179	233	147	228
West South Central	160	170	92	194	150	137	121	161	131	118
Mountain	259	137	203	155	213	109	120	118	120	82
Pacific	105	149	87	117	131	71	113	75	109	[8]84

[2] Covington, Ky., not included.
[3] Worcester, Mass., not inclued.
[4] Spokane, Wash., non included.
[5] Trenton, N. J., not included.
[6] Trenton, N. J., not included.
[7] Grand Forks, N. Dak., not included.
[8] Tacoma, Wash., not included.
[9] Trenton, N. J., and Tacoma, Wash., not included.

Number of cities included in summary of weekly reports, and aggregate population of cities in each group, approximated as of July 1, 1925 and 1926, respectively

Group of cities	Number of cities reporting cases	Number of cities reporting deaths	Aggregate population of cities reporting cases		Aggregate population of cities reporting deaths	
			1925	1926	1925	1926
Total	103	96	29,944,996	30,473,129	29,251,658	29,764,201
New England	12	12	2,176,124	2,206,124	2,176,124	2,206,124
Middle Atlantic	10	10	10,346,970	10,476,970	10,346,970	10,476,970
East North Central	16	16	7,481,656	7,655,436	7,481,656	7,655,436
West North Central	14	11	2,594,962	2,634,662	2,461,380	2,499,036
South Atlantic	21	21	2,716,070	2,776,070	2,716,070	2,776,070
East South Central	7	7	993,103	1,004,953	993,103	1,004,953
West South Central	8	6	1,184,057	1,212,057	1,078,198	1,103,695
Mountain	9	9	563,912	572,773	563,912	572,773
Pacific	6	4	1,888,142	1,934,084	1,434,245	1,469,144

FOREIGN AND INSULAR

THE FAR EAST

Report for week ended May 1, 1926.—The following report for the week ended May 1, 1926, was transmitted by the Far Eastern Bureau of the health section of the League of Nations' Secretariat, located at Singapore, to the headquarters at Geneva.

Port	Plague		Cholera		Small-pox	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
Bombay	----	0	----	0	34	19
Madras	----	0	----	0	8	1
Rangoon	----	9	----	22	2	0
Karachi	----	1	----	0	14	5
Negapatam	----	0	----	0	----	0
Chittagong	0	0	0	0	0	0
Colombo	0	0	0	0	0	0
Basra	0	0	0	0	2	2
Singapore	0	0	0	0	1	0
Port Swettenham	0	0	0	0	0	0
Penang	0	0	0	0	0	0
Batavia	0	0	0	0	0	0
Surabaya	0	0	0	0	0	0
Samarang	0	0	0	0	0	0
Cheribon	0	0	0	0	0	0
Belawan Deli	0	0	0	0	0	0
Palembang	0	0	0	0	0	0
Sabang (Rhio)	0	0	0	0	0	0
Makassar	0	0	0	0	0	0
Menada	0	0	0	0	0	0
Banjermassin	0	0	0	0	0	0
Balik-Papan	0	0	0	0	0	0
Sandakan	0	0	0	0	0	0
Kuching (Sarawak)	0	0	0	0	0	0
Timor Dilly	0	0	0	0	0	0
Manila	0	0	1	1	0	0
Iloilo	0	0	0	0	0	0
Jolo	0	0	0	0	0	0
Cebu	0	0	0	0	0	0
Zamboanga	0	0	0	0	0	0
Bangkok	1	3	143	88	6	3
Saigon and Cholon	0	0	40	29	0	0
Haiphong	0	0	0	0	0	0
Tourane	0	0	0	0	0	1
Hongkong	0	0	0	0	0	0
Shanghai	0	0	0	0	----	1
Amoy	0	0	0	0	5	3
Nagasaki	0	0	0	0	0	0
Yokohama	0	0	0	0	0	0
Simonoseki	0	0	0	0	0	0
Moji	0	0	0	0	1	0
Kobe	0	0	0	0	1	0
Osaka	0	0	0	0	0	0
Niigata	0	0	0	0	0	0
Tsuruga	0	0	0	0	0	0

Port	Plague		Cholera		Small-pox	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
Hakodate	0	0	0	0	0	0
Keelung (Formosa)	0	0	0	0	0	0
Fusan	0	0	0	0	0	0
Chemulpo	0	0	0	0	0	0
Dairen	0	0	0	0	5	1
Antung	0	0	0	0	0	0
Mukden	0	0	0	0	0	0
Changchun	0	0	0	0	0	0
Adelaide	0	0	0	0	0	0
Brisbane	0	0	0	0	0	0
Fremantle	0	0	0	0	0	0
Melbourne	0	0	0	0	0	0
Sydney	0	0	0	0	0	0
Rockhampton	0	0	0	0	0	0
Townsville	0	0	0	0	0	0
Port Darwin	0	0	0	0	0	0
Broome	0	0	0	0	0	0
Port Moresby	0	0	0	0	0	0
Auckland	0	0	0	0	0	0
Wellington	0	0	0	0	0	0
Christchurch	0	0	0	0	0	0
Invercargill	0	0	0	0	0	0
Noumea (New Caledonia)	0	0	0	0	0	0
Honolulu	0	0	0	0	0	0
Suez	1	1	0	0	0	0
Tor Quarantine Station	0	0	0	0	0	0
Alexandria	0	0	0	0	0	0
Port Said	0	0	0	0	0	0
Port Sudan	0	0	0	0	0	0
Mombasa (Kenya)	0	0	0	0	0	0
Massaqua (Erythræa)						
Massowah	0	0	0	0	0	0
Djibuti	0	0	0	0	0	0
Berbera	0	0	0	0	0	0
Mozambique	0	0	0	0	0	0
Lourenco Marques	0	0	0	0	0	0
Durban	0	0	0	0	0	0
East London	0	0	0	0	0	0
Port Elizabeth	0	0	0	0	0	0
Cape Town	0	0	0	0	0	0
Port Louis (Mauritius)	0	0	0	0	0	0
Seychelles	0	0	0	0	0	0

BAHAMA ISLANDS

Quarantine restrictions against Florida removed.—A report dated May 1, 1926, states that the quarantine against ships arriving from Florida, which was established March 25, 1926 (Public Health Reports, April 30, 1926, p. 857), had been removed. However, all persons arriving at Nassau are required to produce certificates of recent vaccination, baggage must be fumigated, and all persons entering the colony from Florida must report to the Bahamas health authorities periodically for a specified period.

CANADA

Communicable diseases—Week ended May 8, 1926.—The Canadian Ministry of Health reports certain communicable diseases in seven Provinces of Canada for the week ended May 8, 1926, as follows:

Disease	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskatchewan	Alberta	Total
Influenza	166				2			168
Poliomyelitis			1					1
Smallpox				12	3	9		24
Typhoid fever			14	1		1	2	18

ECUADOR

Plague—Guayaquil—April 1–15, 1926.—During the period April 1 to 15, 1926, one case of plague with one death was reported at Guayaquil, Ecuador.

Plague-infected rats.—During the same period 9,497 rats were taken at Guayaquil, of which 49 were found plague-infected.

MADAGASCAR

Plague—March 1–15, 1926.—During the period March 1 to 15, 1926, 111 cases of plague with 106 deaths were reported in the Island of Madagascar, occurring mainly in the Provinces of Moramanga and Tananarive. The urban occurrence was reported as follows: *Tamatave*, port, 1 fatal case; *Tananarive*, interior, 21 cases with 21 deaths. The types of the disease were bubonic (cases, 40); pneumonic (cases, 52); septicemic (cases, 19). For further information relative to distribution of occurrence see page 1082.

PANAMA CANAL

Communicable diseases—March, 1926.—During the month of March, 1926, communicable diseases were reported in the Canal Zone and at Colon and Panama, as follows:

Disease	Canal Zone		Colon		Panama		Infected in other localities		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Chicken pox	6		1		3				10	
Diphtheria	1		2		7	1	1		11	1
Dysentery	3		1		5		4	1	13	1
Hookworm		1	1		38		39		78	1
Leprosy		2					2		2	2
Malaria	38	1			2		35		75	1
Measles	4		4		5		2		15	
Meningitis					1	1	1		2	1
Mumps	2						1		3	
Pneumonia [1]				5		18		2		25
Poliomyelitis							1		1	
Tuberculosis [1]		4		9		24		2		39
Typhoid fever			1						1	
Whooping cough			1		4				5	

[1] Only deaths reported.

PHILIPPINE ISLANDS

Examinations for cholera during six months ended March 31, 1926.—During the six months ended March 31, 1926, 3,963 steerage passengers leaving Manila for United States ports were examined for cholera. Thirty-seven stool specimens were found positive for cholera vibrios. Twelve cholera carriers were found among a total of 113 passengers and crew of an interisland vessel.

SIAM

Cholera—Increased prevalence—Bangkok—February 6–April 3, 1926.—During the period February 6 to April 3, 1926, 505 cases of cholera with 331 deaths were reported at Bangkok, Siam. These figures are in excess of those reported for any similar period since the beginning of the present outbreak in October, 1925. For the period October 10, 1925, to April 3, 1926, 1,082 cases with 674 deaths have been reported. Population of city and suburbs, 745,640.

UNION OF SOUTH AFRICA

Plague—Orange Free State—March 28–April 3, 1926.—During the week ended April 3, 1926, five (fatal) cases of plague were reported in the Orange Free State, Union of South Africa. Of these, one case was European and occurred in Brandfort district, making four fatal cases of plague of the pneumonic form occurring in Europeans living on the same farm. For distribution of occurrence according to locality see page 1082.

VIRGIN ISLANDS

Precautions against smallpox.—A report from St. Thomas, Virgin Islands, dated May 8, 1926, states that precautions are being taken against the importation of mild smallpox from Guadeloupe and Martinique. It is said that one important source of danger is unregistered sloops and vessels which carry on illicit trade with southern islands.

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER

The reports contained in the following tables must not be considered as complete or final as regards either the lists of countries included or the figures for the particular countries for which reports are given.

Reports Received During Week Ended May 28, 1926 [1]

CHOLERA

Place	Date	Cases	Deaths	Remarks
India				Feb. 7–Mar. 13, 1926: Cases, 13,247; deaths, 7,809.
Madras	Apr. 11–17	1		
Rangoon	Apr. 4–10	4	4	
Japan	Jan. 17–30	5		
Bangkok	Feb. 6–Apr. 3	505	331	Oct. 10, 1925–Apr. 3, 1926: Cases, 1,082; deaths, 674.

PLAGUE

Ecuador:				
Guayaquil	Apr. 1–15	1	1	Rats taken: 9,497; rats infected, 49.
Latacunga	Apr. 12			Present.
Egypt				Apr. 2–8, 1926: Cases, 2. Jan. 1–Apr. 8, 1926: Cases, 10; corresponding period, 1925, cases, 21.
Alexandria	Apr. 16	1		Bubonic.
Suez	Apr. 2–8	1		Do.
Do	Apr. 19	2		Do.
India				Feb. 7–Mar. 13, 1926: Cases, 36,161; deaths, 27,955.
Bombay	Mar. 28–Apr. 3	1	1	
Karachi	Apr. 4–17	11	4	
Madras	Apr. 11–17	25	18	For Presidency.
Rangoon	Apr. 4–10	6	7	
Iraq:				
Bagdad	Mar. 14–20	3	2	
Java:				
Batavia	Mar. 27–Apr. 2	1	1	Province.
Cheribon	Feb. 28–Mar. 6		1	
Koeningan	do		1	
Pekalongan	do		34	
Tegal	do		1	
Madagascar				March 1–15, 1926: Cases, 111; deaths, 106. Bubonic, pneumonic, septicemic.
Fort Dauphin Province	Mar. 1–15	2	2	Septicemic.
Moramanga Province	do	5	3	Bubonic and septicemic.
Tamatave (town)	do	1	1	Seaport. Bubonic.
Tananarive Province				March 1–15, 1926: Cases, 103; deaths, 79. Bubonic cases, 35, deaths, 32; pneumonic, cases, 36, deaths, 36; septicemic, cases, 22, deaths, 11.
Tananarive Town	Mar. 1–15	21	21	Bubonic, 1; pneumonic, 16; septicemic, 4.
Nigeria	Dec. 1–31	35	28	
Do	Jan. 1–31	24	21	
Russia	Nov. 1–30	51		
Siam	Dec. 27–Jan. 30	16	9	
Straits Settlements:				
Singapore	Mar. 14–20	1	1	
Union of South Africa:				
Orange Free State				Mar. 28–Apr. 3, 1926: Cases, 5;
Brandfort District	Mar. 28–Apr. 3	1	1	Native 4; European, 1; type, disease, pneumonic.
Hoopstad District	do	3	3	Native.
Winburg District	do	1	1	Do.

[1] From medical officers of the Public Health Service, American consuls, and other sources.

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received During Week Ended May 28, 1926—Continued

SMALLPOX

Place	Date	Cases	Deaths	Remarks
Brazil:				
Para	Apr. 11-24	3	2	
Canada:				
Manitoba	May 2-8	3		
Ontario	do	12		
Sarnia	Apr. 25-May 8	5		
Saskatchewan	May 2-8	9		
China:				
Dairen	Mar. 15-Apr. 4	8	4	
Foochow	Apr. 4-10			Present.
Harbin	Mar. 18-Apr. 15	8		
Hongkong	Mar. 28-Apr. 3	4		
Egypt:				
Alexandria	Mar. 19-Apr. 8	39	4	
France	Jan. 1-31	57		
Gold Coast	do	36	3	
Guadeloupe	May 10			Reported prevalent.
India				Feb. 7-Mar. 20, 1926: Cases, 41,558; deaths, 9,138.
Bombay	Mar. 28-Apr. 3	32	16	
Karachi	Apr. 4-17	11	4	
Madras	Apr. 11-17	8	1	
Rangoon	Apr. 4-10	8		
Indo-China (French):				
Saigon	Mar. 22-28	2		
Italy				Jan. 17-Feb. 20, 1925: Cases, 14.
Catania	Apr. 18-25	6		
Japan:				
Nagasaki	do	1		
Java:				
Batavia	Mar. 13-19	1		
Surabaya	Feb. 28-Mar. 6	6	2	
Martinique	May 10			Reported prevalent.
Mexico:				
Aguascalientes	May 2-8		2	
Guadalajara	Apr. 28-May 10		4	
Mexico City	Apr. 18-24	1		Including municipalities in Federal District.
San Luis Potosi	May 2-8		3	
Nigeria	Dec. 1-31	42		
Do	Jan. 1-31	135	1	
Portugal:				
Lisbon	Apr. 5-25		3	
Oporto	Apr. 18-24	1		
Russia	July-Nov	1,884		Later than previously published reports.
Siam:				
Bangkok	Mar. 28-Apr. 3	7	1	
Straits Settlements:				
Singapore	Mar. 21-27	1	1	
Switzerland	Jan. 31-Feb. 27	11		
Tripolitania	July 1-Dec. 31	34		
Do	Jan. 1-31	3		
Turkey:				
Constantinople	Mar. 9-23	2	3	

TYPHUS FEVER

Bulgaria	Jan. 1-31	42		
Czechoslovakia	do	32		
Hungary	do	6		
Lithuania	Nov. 1-Dec. 31	17		
Do	Jan. 1-31	16	1	
Morocco	do	57		
Palestine:				
Haifa district	Apr. 13-19	1		
Poland	Jan. 17-Feb. 13	421	31	
Russia	Nov. 1-30	1,945		
Rumania	Nov. 1-Dec. 31	164	19	
Turkey:				
Constantinople	Mar. 25-31	1	1	
Union of South Africa:				
Natal—				
Durban	Mar. 28-Apr. 3	2	1	

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926[1]

CHOLERA

Place	Date	Cases	Deaths	Remarks
Chosen	October-November, 1925.	12	5	
French Settlements in India	Dec. 1-31	880	712	
India				Oct. 18, 1925, to Jan. 2, 1926: Cases, 21,316; deaths, 12,371. Jan. 3-Feb. 6, 1926: Cases, 17,858; deaths, 10,050.
Calcutta	Nov. 1-28	101	89	
Do	Dec. 6-26		54	
Do	Dec. 27-Jan. 16		41	
Do	Jan. 24-Apr. 3	464	417	
Madras	Nov. 15-Jan. 2	174	70	
Do	Jan. 3-Apr. 10	145	90	
Rangoon	Nov. 8-Dec. 3	4	4	
Do	Jan. 24-Mar. 27	13	10	
Indo-China				September-December, 1925: Cases. 11; deaths, 7.
Province—				
Annam	Sept. 1-30	2	2	
Cambodia	Dec. 1-31	2	1	
Cochin China	Sept. 1-Dec. 31	6	4	
Saigon	Jan. 4-17	2	2	
Tonkin	Sept. 1-Nov. 30	3		Including 100 square kilometers of surrounding country.
Japan	Aug. 30-Oct. 17	409		
Do	Oct. 25-Dec. 26	113		
Philippine Islands:				
Manila	Nov. 9-Jan. 3	15	10	
Do	Jan. 4-Mar. 6		27	
Province—				
Bataan	Nov. 30-Dec. 26	29	25	
Do	Jan. 2-16	1	1	
Bantangas	Jan. 24-Feb. 20	13	13	
Bohol	Jan. 23-30	1	1	
Bulacan	Oct. 18-Nov. 7	92	64	
Do	Nov. 23-Dec. 31	200	88	
Do	Jan. 2-30	6	6	
Laguna	Nov. 23-Dec. 26	18	14	
Do	Jan. 24-Feb. 6	5	6	
Leyte	Jan. 3-9	2	2	
Mindoro	Dec. 20-31	35	30	
Nueva Ecija	Nov. 30-Dec. 13	7	5	
Pampanga	Nov. 1-7	1	1	
Do	Nov. 23-Dec. 31	113	85	
Do	Jan. 2-Mar. 3	39	35	
Rizal	Sept. 27-Nov. 21	75	21	
Do	Dec. 21-30	14	11	
Do	Jan. 3-Feb. 20	89	30	
Romblon	Nov. 8-Dec. 13	27	14	
Russia	May-June	7		
Do	July-August	4		
Siam:				
Bangkok	Oct. 4-Nov. 14	108	68	
Do	Nov. 22-Dec. 26	270	149	
Do	Dec. 27-Mar. 13	398	275	
Do	Mar. 21-27	90	52	
On vessel:				
Steamship	Oct. 3	9		Arrived at Bangkok, Siam: Cases in coolie passengers.

PLAGUE

Argentina				Jan. 24-30, 1926: 6 cases, occurring in interior Provinces of Salta and Santa Fe.
Buenos Aires	Jan. 24-30	1		
Azores:				
St. Michaels	Jan. 17-Apr. 3	9	4	
Belgium:				
Vilvorde	Dec. 1-8	1	1	
Brazil:				
Bahia	Nov. 8-Dec. 28	3	1	
Do	Dec. 27-Jan. 30	4	2	
Santos	Dec. 8-21		2	
Sao Paulo	Reported Mar. 25	4	1	
British East Africa:				
Kenya—				
Kisumu	Nov. 22-Dec. 5	1	2	
Do	Jan. 31-Mar. 20	15	3	
Uganda Protectorate	Sept. 1-Dec. 31	468	426	
Do	Jan. 1-31	109	101	

[1] From medical officers of the Public Health Service, American consuls, and other sources.

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

PLAGUE—Continued

Place	Date	Cases	Deaths	Remarks
Canary Islands:				
La Laguna	Dec. 24	3	2	
Las Palmas	do	1		
Do	Jan. 7	1	1	
Santa Cruz de Tenerife	Dec. 18-27	3		
Do	Dec. 28-Feb. 1	3		
Celebes:				
Makassar	Dec. 29-Feb. 2	12	12	Netherlands East Indies.
Ceylon:				
Colombo	Nov. 15-Dec. 5	3	3	1 plague rodent.
Do	Dec. 27-Jan. 16	2	2	
Do	Jan. 24-Mar. 6	5	5	Feb. 14-20, 1926: Two plague rodents.
China:				
Nanking	Nov. 15-Mar. 27			Prevalent.
Ecuador:				
Ambato	Mar. 31		5	
Eloy Alfaro	Jan. 1-15	1		
Guayaquil	Nov. 1-Dec. 31	31	12	Rats taken, Nov. 1-Dec. 31, 1925, 49,370; rats found infected, 281.
Do	Jan. 1-Mar. 31	62	27	Rats taken, Jan. 1-Mar. 31, 1926, 64,002; rats found infected, 543.
Recreo (country estate)	do	1		
Egypt				Jan. 1-Dec. 9, 1925: Cases, 138.
Alexandria	Mar. 10-18	2	1	
Beni Suef	Nov. 18	1	1	
Fayoum Province	Dec. 3-9	1	1	
Gharbia Province	Mar. 9-30	5	3	
Mina Province	Mar. 4	1	1	
Suez	Mar. 27	1	1	
Greece:				
Athens	Nov. 1-30	18	4	Including Piræus.
Do	Jan. 1-Mar. 31	25	4	
Herakleion	Feb. 4	1		On island of Crete.
Patras	Nov. 13-Dec. 12	4	1	
Hawaii Territory	Feb. 2			1 plague-infected rodent found near Hamakua Mill Co.
Hawaii—				
Honokaa	Mar. 16	2		1 death suspected plague.
Kakuihaela	Mar. 19	1	1	
Paauilo				Jan. 29, 1926: Plague-infected rat found in vicinity.
India				Oct. 18, 1925, to Jan. 2, 1926: Cases, 15,135; deaths, 10,677.
Bombay	Dec. 6-12	1	1	
Do	Jan. 3-Feb. 20		8	
Do	Mar. 7-13	4	2	Jan. 3-Feb. 6, 1926: Cases, 17,402, deaths, 13,598.
Calcutta	Dec. 6-12		1	
Karachi	Nov. 1-Dec. 19	4	3	
Do	Feb. 21-Apr. 3	7	5	
Madras Presidency	Oct. 25-Nov. 7	75	41	
Do	Nov. 15-21	35	22	
Do	Dec. 20-26	108	64	
Do	Jan. 3-Feb. 20	971	617	
Do	Feb. 20-Mar. 20	258	156	
Rangoon	Oct. 25-Dec. 26	23	15	
Do	Dec. 27-Apr. 3	113	102	
Indo-China				September-December, 1925: Cases, 28; deaths, 26.
Province—				
Cambodia	Sept. 1-Nov. 30	13	13	
Cochin China	Sept. 1-Dec. 31	15	13	
Iraq:				
Bagdad	Dec. 13-Jan. 2	7	3	
Do	Jan. 10-Mar. 13	75	44	
Java:				
Batavia	Oct. 24-Nov. 6	94	89	Province.
Do	Nov. 14-Jan. 1	315	297	
Do	Jan. 2-Mar. 12	483	468	
Do	Mar. 19-26	18	18	
Cheribon	Sept. 27-Oct. 17		166	
Do	Nov. 15-Dec. 26		198	
Do	Jan. 3-Feb. 27		190	
Djokjakarta	Oct. 20-Nov. 9			Epidemic in 1 locality
Kediri	Dec. 7			Do.
Koeningan	Dec. 27-Jan. 16		114	
Do	Feb. 7-27		102	
Pekalongan	Sept. 27-Oct. 17		42	
Do	Nov. 8-Dec. 26		252	
Do	Feb. 14-27		89	

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

PLAGUE—Continued

Place	Date	Cases	Deaths	Remarks
Java—Continued.				
Probolinggo	Feb. 12			Epidemic. Port.
Rembang	Oct. 20			Do.
Surabaya	Oct. 11-Dec. 26	59	59	
Do	Dec. 27-Mar. 13	42	42	
Tegal	Sept. 27-Oct. 17	6	6	
Do	Nov. 8-Dec. 26		31	
Do	Feb. 21-27		10	
Madagascar				Nov. 1-December, 1925: Cases, 632; deaths, 593. Jan. 1-31, 1926: Cases, 611; deaths, 565.
Province—				
Ambositra	Dec. 16-31	9	7	
Do	Jan. 1-15	2	2	
Fort Dauphin	Sept. 16-30	6	3	
Do	Jan. 16-Feb 15	2	2	
Itasy	Sept. 16-Oct. 30	20	20	
Do	Nov. 16-Dec. 31	34	34	
Do	Jan. 1-15	29	29	
Do	Feb. 1-15	29	29	
Moramanga	Sept. 16-Dec. 31	49	48	
Do	Jan. 1-Feb. 28	46	44	
Tananarive				Sept 16-Nov. 30, 1925: Cases, 368; deaths, 341. Dec. 16-31, 1925: Cases, 152; deaths, 143. Jan. 1-Feb. 28, 1926: Cases, 480; deaths, 407.
Town—				
Tamatave (Port)	Sept. 16-Nov. 30	42	11	
Do	Feb. 1-15	4	2	
Tananarive	Sept. 16-30	2	2	
Do	Nov. 1-30	11	11	
Do	Jan. 1-Feb. 28	19	19	
Mauritius Island	Sept. 20-Dec. 26	21	18	
Moca	Dec. 1-31	2	2	
Pamplemousses	Oct. 1-Nov. 30	3	2	
Port Louis	Oct. 1-Dec. 31	13	9	
Rivière du Rempart	October	2		
Nigeria	Aug. 1-Nov. 30	559	419	
Persia:				
Teheran	Oct. 21-Nov. 21		12	
Peru				January-March, 1926: Cases, 383, deaths, 148.
Barranca and Supo	Mar. 1-31	4	6	
Cañete	do	1		
Caras	do			Present.
Cascas	do	15	5	
Chiclayo	do		4	
Chimbote	do	16	8	Country estates.
Chincha	do	14	5	
Contumaza	do	12		
Cutorvo	do			Present.
Huacho	Jan. 26	15		Port 60 miles north of Callao.
Lacranmarca	Mar. 1-31	6		
Lima	Jan. 1-31	20		In hospital. Some cases in Province.
Mollendo	do			12 or 15 cases reported unofficially.
Do	Mar. 1-31			
Moro	do			Present.
Otuzco	do	1		
Pacasmayo	do	2	1	
Salaverry	do	5	2	
San Pablo	do			Do.
Trujilo	do	15	5	
Russia	May-June	67		
Do	July-October	166		
Senegal	September-October.	45	25	
Siam	Aug. 23-Dec. 26	65	53	
Bangkok	Nov. 15-28	3	3	
Do	Jan. 3-30	38	33	
Do	Feb. 7-20	11	5	
Do	Feb. 28-Mar. 20	3	2	
Straits Settlements:				
Singapore	Nov. 1-Dec. 5	8	8	
Do	Jan. 3-9	2	2	
Syria:				
Beirut	Nov. 11-20	1		
Do	Jan. 21-31	1		

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

PLAGUE—Continued

Place	Date	Cases	Deaths	Remarks
Union of South Africa				Mar. 7-13, 1926: Cases, 3; European, 2. Mar. 21-27, 1926: Cases, 12; deaths, 4.
Cape Province—				
Kimberley district	Dec. 13-19	1		
Middelburg district	Dec. 6-12	1		European.
Steynsburg district	Nov. 15-21	1		Native. On farm.
Winburg district	Feb. 21-27	1		
Orange Free State				Mar. 14-20, 1926; Cases, 4; deaths, 5, of which 2 deaths were of Europeans and 1 native, previously reported as cases Mar. 7-13, 1926.
Boshof district	Nov. 29-Dec. 5	1	1	In native.
Bothaville district	Dec. 6-12	1	1	Native. On farm.
Grandfort district	Mar. 21-27	3	1	European, in same family, pneumonic.
Hoopstad	Mar. 7-27	5	1	
Kroonstad district	Mar. 14-20	1		Native. On farm.
Winburg	Mar. 14-27	10	4	
On vessel:				
Steamship Cid				Jan. 29, 1926. Plague rat. At Buenaventura, Colombia. Rat was killed while jumping ashore from vessel.

SMALLPOX

Algeria:				
Algiers	Nov. 21-Dec. 31	177		
Do	Jan. 1-10	64		
Do	Jan. 21-Apr. 10	75		
Arabia:				
Aden	Nov. 29-Dec. 5	1		Imported.
Do	Jan. 10-Mar. 6	10	1	
Argentina:				
Rosario	October		1	
Australia:				
Queensland—				
Brisbane	Dec. 9-15	1		
Azores:				
Fayal Island	Feb. 2-Apr. 11			Present. Reported as alastrim.
Bahamas	Feb. 23			In Nassau district. Stated to have been imported.
Brazil:				
Manaos	Dec. 1-31		12	
Do	Jan. 31-Feb. 20		6	
Para	Jan. 10-Mar. 20	30	6	
Rio de Janeiro	Nov. 1-28	134	72	
Do	Dec. 6-26	65	26	
Do	Dec. 27-Apr. 3	279	224	June 27, 1925-Mar. 20, 1926. Cases, 1,089; deaths, 580.
British East Africa:				
Kenya—				
Mombasa	Nov. 15-Dec. 19	14	6	
Do	Dec. 27-Mar. 20	2		
Tanganyika territory—				
Dar-es-Salaam	Feb. 21-27	1		
Uganda Protectorate	Sept. 1-Oct. 31	8	4	
British South Africa:				
Northern Rhodesia	Jan. 5-11	2		
Southern Rhodesia	Nov. 13-Dec. 23	3		
Canada				Sept. 13-Jan. 2: In 7 Provinces, 186 cases. Jan. 3-Feb. 27, 1926: Cases, 277.
Alberta				Jan. 3-May 1, 1926: Cases, 70.
Calgary	Dec. 13-19	1		From Drumheller, vicinity of Calgary.
British Columbia—				
Vancouver	Jan. 4-Mar. 27	2		
Victoria	Mar. 21-27	2		
Manitoba				Jan. 3-May 1, 1926: Cases, 75.
Winnepeg	Dec. 13-19	2		
Do	Jan. 3-Apr. 10	16	1	

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

SMALLPOX—Continued

Place	Date	Cases	Deaths	Remarks
Canada—Continued.				
New Brunswick—				
Northumberland	Dec. 6-13	1		
Ontario				Dec. 1-31, 1925: Cases, 32. Jan. 3-May 1, 1926: Cases, 257.
Admaston	Jan. 1-Feb. 1	16		Township.
Alice and Fraser	Feb. 1-28	6		Do.
King	do	7		Do.
Wilmot	do	6		Do.
Belleville	do	4		
Kingston	Mar. 8-14	1		
Kitchener	do	26		
North Bay	Feb. 14-Mar. 14	7		
Ottawa	Dec. 6-12	2		
Do	Jan. 3-Feb. 6	2		
Sarnia	Mar. 14-Apr. 17	4		
Toronto	Dec. 27-Jan. 2	1		
Do	Jan. 3-May 1	28		
Trenton	Jan. 3-Apr. 17	15		
Saskatchewan				Jan. 3-May 1, 1926: Cases, 122.
Moose Jaw	Jan. 3-Mar. 20	2		
Regina	Jan. 24-May 1	5		
Saskatoon	Feb. 14-20	1		
Ceylon:				
Colombo	Dec. 6-12	1		Port case.
Do	Jan. 3-Feb. 6	5		
Chile:				
Punta Arenas	Dec. 13-26		8	
Do	Dec. 27-Jan. 2		4	
China:				
Amoy	Oct. 25-Dec. 19		1	
Do	Jan. 10-Apr. 3		26	
Antung	Dec. 7-20	2		
Do	Mar. 21-Apr. 4	1		
Changsha	Feb. 21-27			Present.
Chungking	Nov. 15-27			Do.
Do	Feb. 28-Apr. 3			Do.
Foochow	Nov. 1-Mar. 20			Do.
Hankow	Nov. 14-Dec. 26	4		
Do	Jan. 10-Mar. 6	3		
Hongkong	Nov. 22-Dec. 26	4		
Do	Jan. 3-Mar. 20	13	5	
Manchuria—				
An-shan	Dec. 6-12	1		
Do	Jan. 10-Mar. 20	9		
Changchun	do	21		
Dairen	Oct. 19-Dec. 27	73	15	
Do	Dec. 28-Mar. 14	79	24	
Fushun	Jan. 17-Mar. 31	3		
Harbin	Jan. 1-Apr. 8	12		
Kai-yuan	Jan. 10-30	4		
Kungchuling	Jan. 31-Feb. 20	2		
Lio-yang	Jan. 17-Mar. 30	5		
Mukden	Oct. 24-Nov. 15	1		
Do	Jan. 24-Feb. 27	4		
Suping Kai	Mar. 14-Apr. 3	2		
Tieh-ling	Oct. 26-Nov. 15	2		
Nanking	Nov. 21-Dec. 26			Do
Do	Dec. 27-Apr 10			Do.
Shanghai	Oct. 25-Jan. 2	37	36	
Do	Jan. 3-Apr. 3	57	134	Cases, foreign only.
Swatow	Nov. 22-Apr. 10			Prevalent.
Tientsin	Nov. 1-Dec. 19	2		
Do	Jan. 23-Feb. 27	2		
Chosen:				
Seishin	Jan. 1-Mar. 31	58	33	
Egypt:				
Alexandria	Dec. 3-31	5	2	
Do	Jan. 8-14	2	1	
Do	Jan. 29-Mar. 18	24	7	
Cairo	Dec. 25-31	14		
Do	Jan. 1-7	3		
Port Said	Feb. 26-Mar. 4	1		
Esthonia				November, 1925: Cases, 3.
France				September-December, 1925: Cases, 253.
Havre	Jan. 25-31		9	
Paris	Mar. 1-31	10	2	

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

SMALLPOX—Continued

Place	Date	Cases	Deaths	Remarks
Gold Coast	September, December.	58	5	
Great Britain:				
England and Wales				Nov. 15–Dec. 26, 1925: Cases, 790; Dec. 27–Apr. 24, 1926: Cases 4,144.
Hull	Dec. 27–Jan. 23	29		
Do	Feb. 7–Mar. 27	9		
Leeds	Jan. 14–Feb. 6	4		
London	Jan. 31–Feb. 6		1	
Newcastle-on-Tyne	Nov. 29–Dec. 19	6		
Do	Dec. 27–Apr. 10	40	1	
Nottingham	Nov. 22–Dec. 26	9		
Do	Dec. 27–Mar. 13	6		
Sheffield	Nov. 22–Dec. 12	7		
Do	Dec. 20–26	3		
Do	Dec. 27–Mar 20	18		
South Shields	Feb. 9			Reported present in severe form.
Greece				Oct. 1–31, 1925: Cases, 16.
Athens	Nov. 1–Dec. 31	18	1	
Do	Jan. 1–Mar. 31	87	6	
Kalamata	Mar. 1–7	1		From Patras.
Saloniki	Feb. 16–Mar. 15		2	
Guadeloupe (West Indies)				Apr. 23, 1926: Present. Alastrim.
India				Oct. 18–Dec. 26, 1925: Cases, 19,472; deaths, 4,440. Dec. 27, 1925–Feb. 6, 1926: Cases, 36,335; deaths, 11,491.
Bombay	Nov. 8–Dec. 26	26	20	
Do	Dec. 27–Mar. 27	260	135	
Calcutta	Nov. 8–Dec. 26	48	25	
Do	Dec. 27–Apr. 3	620	397	
Karachi	Nov. 1–21	23		
Do	Nov. 29–Dec. 5	4	2	
Do	Dec. 13–19	3		
Do	Dec. 29–Apr. 3	102	32	
Madras	Nov. 15–Dec. 26	17	5	
Do	Dec. 27–Apr. 10	135	24	
Rangoon	Oct. 25–Dec. 26	7	1	
Do	Dec. 27–Jan. 16	13	1	
Do	Jan. 24–Mar. 6	70	17	
Do	Mar. 21–Apr. 3	20	7	
Indo-China				September–November, 1925: Cases, 346; deaths, 86.
Province—				
Annam	Sept. 1–Dec. 31	232	44	
Cambodia	do	84	34	
Cochin China	do	106	51	
Saigon	Dec. 21–27	2	1	
Do	Jan. 1–Mar. 21	12	2	Including 100 kilometers of surrounding country.
Tonkin	Sept. 1–Dec. 31	153	2	
Iraq:				
Bagdad	Nov. 1–Dec. 26	19	15	Sept. 6–Oct. 17, 1925: Cases, 81; deaths, 40.
Do	Dec. 27–Mar. 13	20	11	
Basra	do	52	42	
Italy				Aug. 2, 1925–Jan. 2, 1926: Cases, 52. Jan. 3–16, 1926: Cases, 12.
Catania	Feb. 15–28	1	1	
Genoa	Jan. 21–Feb. 10	4		
Rome	Oct. 12–25	1		
Do	Feb. 22–28	1		Occurring in consular district.
Jamaica				Nov. 29–Dec. 26, 1925: Cases, 95. Dec. 27, 1925–Apr. 24, 1926: Cases, 509. Reported as alastrim.
Kingston	Nov. 29–Dec. 26	43		Reported as alastrim.
Do	Dec. 27–Jan. 30	48		Do.
Do	Feb. 28–Apr. 24	36		Do.
Japan:				
Kobe	Mar. 14–Apr. 17	3		
Nagasaki	Feb. 15–21	1		
Taiwan	Nov. 11–Dec. 10	3		
Do	Mar. 21–31	3		Formosa.
Yokohama	Dec. 14–20	1		
Do	Feb. 23–Apr. 10	67	11	
Java:				
Batavia	Oct. 24–Dec. 25	8		
Do	Feb. 20–Mar. 5	5		
Buitenzorg	Nov. 29–Dec. 5	1		
Cheribon	Nov. 8–Dec. 12	2		
Do	Jan. 31–Feb. 6		1	

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

SMALLPOX—Continued

Place	Date	Cases	Deaths	Remarks
Java—Continued.				
Kraksaan	Oct. 11–17	11		
Malang	Oct. 11–Dec. 26	2		
Do	Dec. 27–Jan. 16	3	2	
North Bantam	Oct. 4–17	4		
Pekalongan	Oct. 25–31	1		
Pontianak	Jan. 31–Feb. 6		1	
Probolinggo	Oct. 11–17	1		
Serang	Feb. 14–27	5		
South Bantam	Feb. 23–Mar. 27	1		
Surabaya	Oct. 11–Dec. 26	633	104	
Do	Dec. 27–Mar. 13	135	41	
Tegal	Oct. 4–10	9	1	
Latvia				December, 1925: Cases, 3.
Malta	Nov. 1–Dec. 21	21	3	
Do	Jan. 1–Feb. 28	20		
Mexico				July–September, 1925: Deaths, 1,157.
Aguascalientes	Dec. 13–Jan. 2	4	3	
Do	Jan. 3–30		7	
Do	Feb. 14–Apr. 24		2	
Durango	Dec. 1–31		1	
Do	Jan. 1–31		2	
Guadalajara	Dec. 27–Apr. 26		21	
Mexico City	Nov. 28–Dec. 5	1		Including municipalities in Federal District.
Do	Jan. 3–Apr. 17	10		Do.
Saltillo	Apr. 4–10	1		
San Luis Potosi	Jan. 17–Mar. 20		53	
Do	Mar. 28–May 1	15	22	
Tampico	Dec. 21–Jan. 2	1	1	
Do	Jan. 2–Mar. 16	8		
Torreon	Nov. 1–Dec. 31		51	
Do	Jan. 1–Mar. 31		65	
Vera Cruz	Mar. 29–Apr. 4	5	1	
Netherlands:				
The Hague	Jan. 30–Mar. 6	2	1	
Nigeria				August–November, 1925: Cases, 347; deaths, 6.
Palestine:				
Hebron	Jan. 26–Feb. 1	2		
Tiberias	Feb. 9–15	1		
Persia:				
Teheran	July 23–Dec. 22		775	
Do	Dec. 23–Feb. 19		99	
Peru:				
Arequipa	Oct. 1–Dec. 31		2	
Poland				Nov. 1–28, 1925: Cases, 9. Jan. 1–16, 1926: Cases, 4.
Portugal				Mar. 1–28, 1926: Deaths, 6.
Lisbon	Oct. 4–31	124		
Do	Nov. 16–Dec. 27		60	
Do	Nov. 14–Dec. 26	187		
Do	Dec. 27–Apr. 17	126	29	
Oporto	Nov. 22–Dec. 19	2	3	
Do	Dec. 27–Mar. 6	3	1	
Rumania	August–October	3		
Russia				May–June, 1925: Cases, 2,333.
Do	July–October	1,563		
Siam				July 12–Sept. 5, 1925: Cases 21; deaths, 6.
Bangkok	Dec. 20–25	3	1	
Do	Dec. 26–Mar. 6	81	37	
Do	Mar. 14–27	14	12	
Sierra Leone:				
Konno district	Dec. 16–31	5		
Spain:				
Madrid	Year 1925		18	
Do	Jan. 1–31		1	
Malaga	Nov. 29–Dec. 5		2	
Do	Dec. 27–Jan. 2		1	
Valencia	Dec. 20–26	1		
Do	Dec. 27–Jan. 2	1		
Do	Jan. 10–Feb. 6	9		
Do	Feb. 14–Apr. 24	12		

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

SMALLPOX—Continued

Place	Date	Cases	Deaths	Remarks
Straits Settlements:				
Penang	Mar. 28-Apr. 3		1	
Singapore	Dec. 20-26	1		
Do	Jan. 10-16	7	1	
	Feb. 7-27			
Sumatra:				
Medan	Feb. 14-27	2		
Switzerland				June 28-Nov. 21, 1925: Cases 62; Dec. 27, 1925-Jan. 30, 1926: Cases, 37.
Lucerne	Oct. 1-Nov. 30	8		
Do	Jan. 1-31	5		
Zurich	Dec. 27-Jan. 2	1		
Trinidad (West Indies):				
Port of Spain	Jan. 1-Apr. 3	12		
Tunisia:				
Tunis	Nov. 21-30	2		
Do	Dec. 11-31	10	1	
Do	Jan. 1-Apr. 20	7		
Union of South Africa:				
Cape Province	Jan. 17-23			Outbreaks.
Orange Free State—				
Kuruman district	Jan. 10-16			Do.
Ladybrand district	Dec. 27-Jan. 2			Do.
Transvaal—				
Belfast district	do			Do.
Germiston district	Jan. 2-9			Do.
Pretoria district	Dec. 6-12			Outbreaks. In native compound.
On vessel	Feb. 21	2		Mexican steamer Montezuma, at Port of Ensenada, Mexico.

TYPHUS FEVER

Algeria:				
Algiers	Nov. 1-Dec. 20	2		
Do	Jan. 1-Apr. 10	13		
Argentina:				
Rosario	Oct. 13-Dec. 31	2		
Bulgaria	Sept. 1-Dec. 31	50	3	
Sofia	Dec. 25-31	1		
Do	Jan. 8-14	2		
Canary Islands:				
Santa Cruz de Teneriffe	Mar. 8-14	1		
Chile				Dec. 15-31, 1925: Cases, 46. Jan. 1-15, 1926: Cases, 23.
Achao	Dec. 15-31	1		
Do	Jan. 1-15	1		
Ancud	do	2		
Antofagasta	Apr. 11-17	1		
Bulnes	Dec. 15-31	1		
Chilian	do	24		
Concepcion	do	6		
Linares	do	1		
Los Angeles	do	5		
Penco	do	2		
Salamanca	do	17		
San Carlos	do	1		
Talca	do	1		
Valparaiso	Nov. 29-Jan. 2	5	2	
Do	Jan. 3-Mar. 27	4		
China:				
Antung	Nov. 29-Dec. 27	5	1	
Do	Jan. 4-Apr. 11	15		
Hongkong	Dec. 27-Jan. 2	1		
Manchuria—				
Harbin	Dec. 17-Feb. 4	3		
Do	Apr. 2-8	1		
Shanghai	Mar. 14-20	1		
Czechoslovakia	October-December	146	1	
Egypt:				
Alexandria	Jan. 8-Feb. 25	2		
Cairo	Nov. 5-Dec. 16	3	2	
Port Said	Nov. 19-25	1		
Do	Mar. 12-18	1		

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

TYPHUS FEVER—Continued

Place	Date	Cases	Deaths	Remarks
Esthonia	Jan. 1-31	6		
Finland				October, 1925: 1 case.
France	July-October	4		
Greece				December, 1925: Cases, 12.
Athens	Nov. 1-30	11	2	
Do	Jan. 1-Mar. 31	45	9	
Saloniki	Dec. 29-Jan. 4	1		
Do	Feb. 2-Mar. 22	2		
Hungary				November-December, 1925: Cases, 16.
Ireland:				
Cork County—				
Cork	Dec. 26-Jan. 1	2		
Do	Jan. 2-8	5		
Dumanway	Nov. 14	1		
Galway County	Oct. 17	1		
Kerry County—				
Listowel	Mar. 7-13	1		Rural district.
Wexford County—				
Gorey	do	1		Do.
Latvia	October-December	12		
Riga	Oct. 1-31	2		
Lithuania				September-October, 1925: Cases, 9; deaths, 1.
Mexico				July-September, 1925: Deaths, 90.
Aguascalientes	Dec. 14-19	1		
Durango	Dec. 1-31		1	
Do	Jan. 1-31		1	
Guadalajara	Dec. 8-28		2	
Do	Dec. 29-Jan. 4		1	
Mexico City	Nov. 22-Dec. 26	50		Including municipalities in Federal District.
Do	Dec. 27-Mar. 20	89		Do.
Do	Mar. 28-Apr. 10	11		Do.
San Luis Potosi	Feb. 6-13		1	
Tampico	Dec. 21-Jan. 10	1	1	
Torreon	November, 1925		1	
Vera Cruz	Feb. 12		1	
Morocco	August-December	93		
Norway				November-December, 1925: Cases, 2.
Palestine:				
Ekron	Mar. 30-Apr. 5	1		
Gaza	Dec. 18	1		
Haifa	Mar. 16-22	1		
Jaffa	Dec. 1-7	1		
Do	Feb. 23-Mar. 1	1		
Nazareth	Nov. 3-9	1		
Ramleh	Mar. 16-22	1		
Safad	Nov. 24-30	1		
Tel-Aviv	do	1		
Do	Mar. 9-15	1		
Tiberias	do	2		
Peru:				
Arequipa	October-December		3	
Do	Feb. 1-Mar. 31		2	
Poland	Oct. 11-Jan. 2	462	44	
Do	Jan. 3-Feb. 6	375	32	
Rumania				July-October, 1925: Cases, 181; deaths, 22.
Constantza	Feb. 1-Mar. 10	2		
Russia				May-June, 1925: Cases, 10,680.
Do				July-October, 1925: Cases, 6,435.
Tunisia:				
Tunis	Mar. 21-31	3		
Turkey:				
Constantinople	Jan. 24-30	3		
Do	Feb. 9-22	5	3	From unofficial sources (press).

CHOLERA, PLAGUE, SMALLPOX, TYPHUS FEVER, AND YELLOW FEVER—Continued

Reports Received from December 26, 1925, to May 21, 1926—Continued

TYPHUS FEVER—Continued

Place	Date	Cases	Deaths	Remarks
Union of South Africa				October, 1925: Cases, 88; deaths, 7 (colored). Cases, European, 7. December, 1925: Cases, 78; deaths, 9. Colored: Cases, 73; deaths, 9. January-February, 1926: Cases, 103; deaths, 28.
Cape Province	Oct. 1-31	63	5	Colored.
Do	Nov. 8-Dec. 31	47	8	
Do	Jan. 1-Feb. 28	126	20	Do.
Grahamstown	Jan. 24-30	2		
Middleburg district	Dec. 6-12	1		European. On farm.
Natal	Oct. 1-Dec. 5	1		
Do	Jan. 1-Feb. 28	11	1	Colored.
Durban	Jan. 3-Mar. 6	4		
Orange Free State	Nov. 29-Dec. 5	23	1	
Do	Dec. 1-31	8	1	
Do	Jan. 1-Feb. 28	8	3	Do.
Bethulia district	Dec. 6-12			Outbreaks.
Bothaville district	do	1		Native. On farm.
Transvaal	Oct. 1-31	1	1	
Do	Dec. 1-31	18		
Do	Feb. 1-28	8	4	
Johannesburg district	Mar. 1-20	3		
Bloemhof district	Dec. 27-Jan. 2			Outbreak. On farm.
Yugoslavia				Jan. 1-Feb. 21, 1926: Cases, 81; deaths, 12.

YELLOW FEVER

Gold Coast	Sept. 1-Dec. 31	4	3	
Nigeria	August-October	3	2	
Senegal	November, 1925	3	2	