

is reduced, and at 43 degrees it was necessary to use two parts per million to get an efficiency of 97.9 per cent. for the total organisms and 98.8 per cent. for the fermenting forms. In general, it may be safely concluded that chlorid of lime is superior to copper sulphate as a germicide for sewage effluents, both on account of efficiency and cheapness, although under special conditions, with soft water and rather high temperatures, it may be that copper would be more suitable. It is certainly more convenient to use.

To sum up, it would appear then that the septic tank, under ordinary conditions where there are no trade wastes calculated to retard bacterial action, is well suited to remove a considerable percentage of the suspended matter in sewage. It requires a small amount of space, can be cheaply operated, and the difficulty of disposing of the stored matter can probably be readily overcome. There seems to be no reason why careful attention to the time sewage is in the tank, with probably some minor changes in construction, should not enable such a system to run for years without being cleaned. The septic tank should not, however, be considered in itself a complete method of properly disposing of sewage, but should be followed by some process which will expose the effluent to further bacterial action in order that the result be what it should.

Until recently the chemical treatment of sewage, like the chemical treatment of waters, has been decidedly out of vogue in most places in this country. Within the past few years, however, interest has been revived in the method, and further investigations and improvements in treating sewage chemically may result in its being used more extensively than formerly. That it is well adapted to handle certain conditions is recognized; whether it is to have a wider application remains to be seen. If conditions change so that authorities demand a sterile as well as an oxidized effluent from sewage disposal plants it is not unlikely that it will be found that such results can be as cheaply and satisfactorily obtained by combining a germicide with chemical precipitation methods as in other ways which would have to be resorted to. In any case, it would seem that the use of chlorin or copper for sterilizing the effluent from any sewage disposal plant is likely to come into more general use.

As was said in the first place, the problem of sewage disposal is one which calls for the greatest amount of adaptation to local conditions, with no single type suitable to all. Under such circumstances we can not afford to be governed by preconceived ideas or prejudice. Wherever possible actual experiments should be conducted with all feasible methods on a large enough scale to actually determine for a given locality the best means of disposing of its sewage. If this is not possible certainly no system should be adopted until after the most careful and thorough investigation by experts uncommitted to any special type. There have been too many examples in the past of installing or rejecting a septic tank or intermittent filters or chemical treatment simply because they succeeded or failed some place else. Let us realize that the question of sanitary sewage disposal is often much more complicated than that of a pure water supply and not fail to give the matter the consideration which it deserves and demands.

Education in the Country.—The old-time notion to place colleges in the woods was correct, and the present tendency to reverse Nature and graduate a stream of blond city neurasthenics to become educated paupers is a disaster.—*Amer. Med.*

FACTORS IN THE PRODUCTION OF COAGULATION NECROSIS.*

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Coagulation necrosis is usually defined as that form of death of tissue in which the proteid suffers change similar to or identical with coagulation. It is known that this condition can be induced by various chemical substances, as acids, alkalies, and metallic salts; by some of the alkaloids; by vegetable poisons, as ricin and abrin; and by bacterial poisons. In addition to these causes it has been suggested that ferments derived from the body cells may, under certain conditions, produce similar effects as in the case of anemic infarcts of the spleen and kidney.

It seemed probable that additional information could be gained of the factors underlying coagulation necrosis by studying the factors underlying the coagulation of culture media, containing blood serum, through bacterial agencies, as well as by experiments upon animals.

A study of the factors underlying the coagulation of blood serum in the form of the well-known Hiss media through the agency of bacteria has shown that this effect is brought about by the organic acids produced in the fermentation of the carbohydrates in the media and a coagulating enzyme produced by the bacteria. The neutralization of the acid in the cultures by means of calcium carbonate (marble) inhibits the coagulation of the media, indicating that the acid is an important factor in the process.

When bacteria are cultivated in bouillon containing dextrose and afterward the cultures are filtered through a Berkefeld filter, these filtrates when added to sterile Hiss media act in a manner similar to, if not identical with, the living organisms. The filtrates induce typical clotting of the media and in this respect their action differs from the action of dilute acids of equal acidity; the dilute acids inducing merely precipitation of the albuminous constituents of the media. The action of the filtrates is also entirely inhibited on neutralization of the acids contained in them, while boiling inhibits the coagulation but does not inhibit the precipitation of the media.

From these facts it seems evident that the coagulation of the blood serum by living bacteria, or by means of culture filtrates, is induced by the combined action of the organic acids and coagulating enzymes produced by the bacteria. In fact, it was possible, by using the method suggested by Conn, to recover the coagulating enzyme from the culture filtrates and obtain identical results with solutions of these enzymes. The conclusion that I have reached on the basis of these studies is that blood serum is coagulated outside the body through the agency of bacteria by altering the electric charge of the colloids in the serum through the combined action of the organic acids and the coagulating enzymes which they produce.

In order to ascertain the influence of bacteria in producing coagulation necrosis and other alterations of the colloids in the body, two lines of experimentation were pursued: (1) The inoculation of animals with living cultures and the simultaneous administration of weak alkalies in an attempt to neutralize the acids formed by the bacteria through fermentation of the carbo-

* Read in the Section on Pathology and Physiology of the American Medical Association, at the Fifty-eighth Annual Session, held at Atlantic City, June, 1907.

hydrates in the body; and (2) the injection of filtrates of cultures of bacteria after they had grown for some time in bouillon containing carbohydrates. These filtrates were employed in their original acid condition as well as after the acidity had been carefully neutralized.

The first line of experiments, in which dilute alkalies were administered to animals after inoculation with living bacteria capable of producing coagulating and carbohydrate fermenting enzymes, yielded negative results. The animals that received the injections of dilute alkalies always died earlier than the control animals inoculated with the same bacteria.

While it has long since been demonstrated that during various infections the alkalinity of the blood is decreased, these experiments demonstrate that the method employed to overcome this effect is not efficacious. If a more appropriate means of maintaining the normal alkalinity of the blood were available it is probable that it would help to throw light upon this as well as other problems concerning infectious processes.

The second series of experiments yielded more fruitful results. The animals injected with the acid culture filtrates died, while the animals injected with equal quantities of the filtrate after neutralization of the organic acids remained alive. In each of two series of experiments made with such filtrates the neutralized filtrates were without noticeable effect. In these experiments culture filtrates of streptococcus lacticus and bacterium diphtheriae were employed. These organisms were cultivated in bouillon, containing 1 per cent. of dextrose or some other carbohydrate, for several weeks or a month.

While it is well known that bacteria produce far less toxic solutions when grown in media containing sugar than in sugar-free media, yet the presence of the sugar does not prevent the formation of some toxin.

The fact that neutralization of the acids in the culture filtrates annulled or, at least, reduced their toxic powers materially shows that the acids in these filtrates are important factors in the production of pathologic effects. Since previous studies have shown that the organic acids and the coagulating enzymes produced by bacteria are instrumental in the coagulation of blood serum outside the body it seems probable that coagulation necrosis induced by various bacteria is due to similar causes.

As none of the animals experimented on with the neutralized culture filtrates died, it has not been possible to approach the problem from the histologic standpoint.

I have tested the influence of nearly all of the different pathogenic bacteria as to their powers of fermenting carbohydrates in the Hiss serum media and have found that all possess the property of producing a marked degree of acidity with dextrose media and many of them also coagulate the serum.

It has been demonstrated by others that the power to produce acids from carbohydrates usually runs parallel with the pathogenic influence exerted by the disease-producing bacteria. The results of the experiments with the culture filtrates likewise point to the importance of the power of fermenting carbohydrates to the pathogenic effects produced by the bacteria.

The studies which I have made indicate that (1) the coagulation of blood serum through bacterial agency is induced directly and indirectly by a coagulating and a carbohydrate fermenting enzyme produced by the

bacteria; and (2) that the inhibition of the effects of the carbohydrate fermenting enzyme alone, through neutralization of the organic acids produced, will annul or materially reduce the pathogenic effects that would otherwise ensue; and (3) if some safe and certain method can be devised for overcoming this mode of offense by the bacteria we shall possess an additional defensive measure against bacterial action in the body.

THE PATHOLOGY OF MIDDLE-EAR SUPPURATION.*

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This topic involves a consideration of the essential nature of the structural and functional changes resulting from pyogenic infection of the middle ear. The limited time allotted for such purpose permits but brief discussion of such alterations and it will be my pleasure to present the varying stages of the disease as nearly as possible in the order in which they occur, considering their progress as concisely as possible.

As a foundation for the correct understanding of conditions underlying the disease, it may not be amiss to refer casually to the anatomic and histologic character of the structures to be dealt with and the provisions Nature has made to prevent or to resist purulent invasion of this organ. In the first place, it must be clearly understood that the middle ear does not mean simply the tympanic cavity. From the clinical point of view, it would probably be proper to accept the statement of Pierce, embodying the idea held by many others, that the middle ear begins at the pharyngeal end of the Eustachian tube and ends only with the most remote pneumatic cell of the temporal bone. Directly connecting channels make it possible for micro-organisms to travel throughout this entire area over the surface of a lining membrane that is histologically similar all the way, and the dependent position of many of these cellular spaces favors the retention of secretions produced as the result of microbic action. Under normal circumstances, the only exposure of the middle ear to the atmosphere is through the tympano-pharyngeal tube, which is opened only intermittently for the admission of air, but, inasmuch as this tube terminates in the nasopharynx, in a region that is more or less constantly inhabited by micro-organisms, it may be said that the middle ear is continually exposed to bacterial assault. In spite of this incessant danger the middle ear enjoys a fair degree of immunity to suppuration.

It may be accepted as proved that the middle ear is normally a sterile cavity. This immunity to infection may be partly due to ability of the mucous membrane to destroy micro-organisms, but is probably more particularly the effect of Nature's providing a mechanical guard against the entrance of germs. The epithelium lining the tympano-pharyngeal tube is of the ciliated variety and the cilia move toward the pharynx, thus obstructing the progress of invading bacteria. Add to this physiologic process the force of an outpouring secretion from the irritated mucous membrane, which naturally seeks exit by this channel, and you have a fairly efficient protective power. Should these sentinels be passed, the

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