hospital. And you will permit me to say that no university medical school in the present day can overlook, without committing suicide, the necessity of establishing a physiological laboratory, and including pathological anatomy in its official curriculum of study.

ON THE CONDITIONS OF EFFICIENT DISINFECTION AND ON SOME NEW FORMS OF DISINFECTANT.

By FRANCIS T. BOND, M.D., B.A.Lond., Medical Officer of Health, Gloucestershire Combined Sanitary District.

THERE are probably few subjects connected with practical hygiene with regard to which more confusion exists in the minds both of the medical profession and the public, than that of disinfection; there are certainly no sanitary appliances upon which more money is wasted, or more confidence falsely placed, than on the so-called disinfectants which are generally employed. Antiseption, or the arrest of putrefaction—a purely temporary process, and even simple deodorisation, or the chemical neutralisation of its results, are confounded with biolysis, or the permanent destruction of life. Nay, more; the mere fact that certain bodies emit powerful odours is assumed to indicate that those odours themselves possess the power of arresting the spread of infection. Unfortunately, the facility with which a little cheap and very disagreeably smelling powder can be scattered about an infected house, or over the mouth of a drain, is too apt to generate, in the minds both of sanitary authorities and of private individuals, an unfounded confidence in its virtues, which too often leads to a disregard of other measures which are of far more real importance, thus producing results from which the community at large suffer. For this state of things medical men are in a large degree responsible. A disinfectant, especially one which has a good strong smell, like a drug with a good strong taste, is an ally which practitioners often have not the courage to discard, even though they may have strong doubts as to the value of its aid. It represents to the patient an amount of potentiality which is measured by the effect it produces on his organs of sense, and offers to him a sort of material guarantee that “something is being done”. Under these circumstances it is, perhaps, not strange that so offensive a body as carbolic acid should still enjoy a large popularity, in spite of the incontestable evidence which has been adduced as to its untrustworthiness as a disinfectant in the way in which it is mostly used; nor, on the other hand, that a liquid, whose deodorant action is so evident both to the eye and nose, as is that of a solution of the alkaline permanganates, should have acquired a reputation as a true disinfectant, to which it has no claims whatever. Of the immense importance of really efficient disinfection, where it is practicable, no one can have any doubt; and in proportion as this conviction is strong, so should be the effort to use, for the purpose, those agencies whose action shows them to be most reliable.

To employ worthless or even feeble instruments, where more trenchant ones are at our service, is to needlessly play into the hands of disease; nor do we less so, when we attempt to use even effective weapons for a service which they cannot perform. If disinfection be worth undertaking at all, it should be done as thoroughly as is practicable; anything like half measures, where whole ones can be conveniently employed, should be actively discouraged, and any attempt to accomplish impossibilities should be rigorously eschewed. In order to have a clear idea of what can and what cannot be done in this direction, it will be well to briefly consider what objects we should have in view when we practise the process of disinfection.

We have the strongest possible reason for believing that certain specific diseases are produced mainly, if not exclusively, by the introduction from without into the bodies of healthy persons of material particles communicated from the bodies of persons suffering under those diseases. The object of all efficient disinfection is, if possible, to destroy the vitality of these particles altogether, or, if it fail in this, to so effectually neutralise it that it shall be arrested sufficiently long to allow these sources of infection to be removed by natural (atmospheric dispersion) or artificial (water-carriage or absorption into the earth) means from the immediate vicinity of the healthy. Whether these particles be of the nature of germs, having an independent life of their own, and developing like seeds or ova when introduced into an appropriate soil; or whether they be merely fragments of diseased tissue or portions of diseased secretions, which act upon the healthy

fluids of the body in a somewhat analogous way to that of a piece of rennet on milk; or whether, lastly, they be independent, free-moving organisms (contagion-bacteria of Traube), generated either spontaneously or by implantation in the fluids of the sick person, which possess the power of making their way into the fluids of the healthy, and there, by their multiplication, setting up the specific disease, we cannot positively say. Probably all of these hypotheses have a justification in fact, each one of them representing the mode of diffusion of one or more special forms of infectious disease. What is equally probable is that some, if not all, of these material sources of infection partake more or less intimately in their composition of that albuminoid character which all primitive forms of life exhibit. And what is still more probable is that, if these sources of infection be independent organisms, they grow and multiply most readily in albuminoid fluids, and that, even where these organisms are not themselves directly destroyed, their vitality and activity are more or less completely arrested by agents, which render albumen physiologically inert, and cut off, as it were, the sources of their subsistence. In the words of Shylock:

“We take their house when we do take the prop
That doth sustain their house; we take their life
When we do take the means whereby they live.”

If, then, we seek to destroy the physiological activity of these infectious particles, there are only two ways in which we can hope to do so. The first of these is, by the employment of agents which effectually destroy all organic bodies; and, in so doing destroy, of course, their reproductive activity. Such agents are heat, and rapidly acting corrosive chemical agents, such as the strong mineral acids. Heat in the dry form can only be conveniently employed for disinfecting purposes by the aid of appliances specially constructed for the purpose, at some considerable expense, and with certain requisite precautions. It therefore is only fitted for use through the interposition of sanitary authorities or public institutions. But heat in the liquid form, in the shape of boiling water, can be readily applied to all washable articles, and if not absolutely destructive of all sources of infection, which is, perhaps, open to doubt, is at any rate a valuable adjunct to any form of chemical disinfection. The corrosive mineral acids, though available in certain limited conditions, as in hospitals and other similar institutions where they can be employed with due precaution for the disinfection of alvine evacuations, are, for obvious reasons, out of the question for general disinfecting purposes; and, though less rapidly, corrosive agents, such as chlorine and sulphurous acid, will probably, if applied for a sufficient length of time and in sufficient quantities, produce the same effect, there are practical difficulties in the way of doing so efficiently, which make them of little or no use, except perhaps when applied in a concentrated gaseous form, for disinfecting articles of clothing or other objects in a closed chamber. As ordinarily employed, in the liquid form (chloride of lime and calcic bisulphite), these agents are merely deodorants, or, at best, antiseptics, which rapidly lose their power, partly from oxydation and partly from volatilisation.

The second method consists in the use of agents which chemically coagulate albumen, and thus render it physiologically inert. The action of such agents is probably twofold: firstly, attacking such elementary organisms as are of an albuminoid character, and gradually destroying them; and, secondly, in so affecting albuminoid liquids, that they become unsuitable as a pabulum for such organisms. It is in this way, probably, that the high antiseptic power of albuminous coagulants is to be explained. As a matter of fact, it will be found that those bodies which have the highest power of preventing putrefaction, and with it the development of free-moving organisms, are mostly energetic coagulators of albumen. It is true, that the power of antiseption is not confined to coagulants, many organic bodies which exercise no apparent influence on albumen possessing it. But, taking the chief metallic salts which act as antiseptics, it will be found that their antiseptic and coagulant properties are closely proportionate.

Hence, then, it is before all things desirable, that any substance which is to be used for disinfecting purposes, should be an energetic coagulator of albumen, not only for the purpose of directly attacking infectious elements, but also of arresting putrefaction. But, though the effective coagulation of albumen is a first requisite in a perfect disinfectant; and, though it would, probably, be sufficient if we had only to deal with the disinfection of organic compounds which had not entered into putrefactive or fermenting decomposition, as a matter of fact, most of the compounds to which disinfectants have to be applied have already advanced to this stage; and it is important, for several reasons, that the results of this process, in the shape of various gaseous products, should be neutralised. This deodorising part of the disinfecting process is essentially a chemical one, and the most efficient of all deodorisers is unquestionably ozone, from the rapidity with which it attacks one of the invariable constituents of all putrefactive emana-

tions, viz. hydrogen. Hence, all active ozonisers are active deodorants. A body may, however, act as a deodoriser without being an ozoniser at all; e.g., metallic salts by their action on sulphuretted hydrogen, and acids and acid salts by their action on ammonia. Looking at the various matters to which a general disinfectant may require to be applied, it will be found in practice desirable that it should have as it were a double deodorising power; one to act on the more purely organic results of decomposition, and the other on sulphuretted hydrogen. For the first of these purposes ozone is, in every way, the most appropriate agent, and it would, of course, be equally applicable for the second of the above objects were there not practical difficulties in the way of employing it in sufficient intensity. For the effect even of a very intense dose of ozone is very soon exhausted on any organic liquid, and the rapidity of this exhaustion is no guarantee of the permanency of the deodorant effect; since organic elements to be attacked by it need not be in a state of decomposition at all, but only in one of unstable equilibrium. Hence, in the use of an ozonising agent, such as the permanganate of potassium, upon a complex organic mass in a state of decomposition, like faeces, the exhaustion of the disinfectant is complete at once, though the process of decomposition itself may not be even temporarily arrested. The process of disinfection is, therefore, under the different conditions in which it may be required, a complex one, and the results to be compassed are not to be obtained in the most satisfactory manner possible from any single agent. The prescription for a disinfectant, like that for a medicine, should be in most cases double, or even treble shotted, if it is to be effective under all circumstances. And even when we have carefully balanced its chemical ingredients with a view to their producing a maximum effect, we have not achieved the whole object in view; for, in addition to considerations of efficiency, are certain others of an economic and practical character which cannot be overlooked. It would not, probably, be difficult to name a dozen organic and inorganic bodies at least, which would be infallible disinfectants if they could be conveniently used, but which, either from their cost or on other grounds, are unavailable.

For these reasons, then, the composition of a disinfectant is a matter of some little difficulty. Its designer has to balance the greatest number of advantages against the least number of disadvantages, and the more completely he can do this, the more effectually will he attain the object he has in view. A few words will be sufficient to explain the practical conditions to be aimed at. In the first place, as those sources of infection which can be most readily dealt with are either presented to us in the liquid form, or can only be energetically attacked by liquid agents, our disinfectant should be either itself a liquid, or, if a solid, should be as largely soluble in water as possible. This condition indicates a fatal objection to the various forms of powders sold for disinfecting purposes, in which carbolic acid, itself an almost insoluble body, is combined with from eighty to ninety per cent. of entirely insoluble matter. Any one who will take the trouble to make a solution of these powders, and then to test the strength of that solution as an antiseptic, will soon convince himself of how little value it is. In the next place, for the reasons stated above, our disinfectant should act as energetically as possible upon albumen consistently with a due regard, amongst other things, for the economic conditions in which it is most likely to be required; e.g., its action over clothes, closet-fittings, etc. This consideration excludes such bodies as the permanganates from the list of effective disinfectants, however useful they may be as deodorants.* To trust to such agents alone as disinfectants in cases of infectious disease is like firing blank cartridge at a tiger.

It may be well here to advert to the idea which seems to prevail somewhat extensively, that carbolic acid is a powerful coagulator of albumen, and that it is upon this property that its antiseptic powers depend. Carbolic acid is, it is true, a fair albuminous coagulant, but it is only when it is brought in contact in mass with an albuminous structure, such as a mucous membrane, or a raw wound. When mixed with a solution of albumen, it is, in consequence of its slight solubility in water, an extremely feeble coagulant, as any one may easily satisfy himself by pouring some of the liquid acid into a solution of egg-albumen in water, or into blood-serum. Even if violently agitated, so as to reduce the acid to an extreme state of comminution, coagulation is very imperfect, probably from each globule of the acid becoming at once coated with a pellicle of coagulated albumen, which prevents further action. If the antiseptic powers of carbolic acid are to be utilised at all (and for certain crude purposes it has some recommendations), it should be combined either with matters which are themselves soluble, or which will promote its solution, and which

will, so far as is practicable, themselves exercise some influence on organic decomposition.*

Having acquired these properties for our disinfectant, we have to a large extent gained others which are very desirable. For instance, as has been before remarked, we shall find that in proportion to its efficacy as an albuminous coagulant, will be its power as an antiseptic. By a judicious selection of a coagulant, we may also obtain a body which shall act upon sulphuretted hydrogen and ammonia, two of the most offensive results of organic decomposition. Most antiseptics are deodorants, though it may be doubted whether in some cases the deodorisation is not more apparent than real, in consequence of the strong odour of the disinfectant masking that of decomposition. Ozone, as has been above observed, is the most effective of all deodorants—hence it is very desirable that an ozoniser of some kind should be combined with our disinfectant. The influence of carbolic acid as a deodorant is possibly—in part, at least—due to its evolving ozone whilst itself is undergoing oxidation: that of chlorine is also partially attributable to the same cause, from its decomposing action on water, though also in a large degree to its direct effect on hydrogenous gases. It may also be assumed that it is desirable that the ozonising influence of our disinfectant should be capable of being exerted not only in solution, but by atmospheric diffusion: and for purposes of mere deodorisation this is, no doubt, important. It would appear that, practically, this object can be most readily attained by the use of certain organic bodies, which in the act of diffusing a volatile aroma, more or less actively evolve either ozone or peroxide of hydrogen (Schönbein's antozone). The use of such bodies for purposes of deodorisation is not to be confounded with any attempt at real atmospheric disinfection. Such an attempt is, I believe, impracticable by any such means. There are, however, three ways in which there is a possibility of achieving such a result: the first, and by far the most effective, is thorough ventilation, which, by sweeping into the outer air, and thus largely diluting, as it were, the infectious elements, reduces *pro tanto* the chances of their prejudicial action, and is probably as beneficial to the sick person as it is to the healthy around him; the second, which is much more problematical, is the diffusion through the infected atmosphere of a corrosive gas, such as sulphurous acid; the third is the diffusion, in the form of spray, of an efficient liquid disinfectant, by means of which the atmosphere may, as it were, be thoroughly washed out.

Of these three methods, the first is obviously the only one which can be practised whilst the sick person occupies the infected room; and it is, in my opinion, ample both then and after convalescence, if combined with careful dusting, washing, and, so far as is possible, liquid disinfection of all surfaces and articles in the infected room.† A good sulphurising effectually deodorises the offensive atmosphere and articles in a sick room, but it is very doubtful whether it does any more. Of how little value the vapour of carbolic acid is for antiseptic purposes is shown by the fact that the decomposition of meat or other readily putrefiable bodies, suspended in an atmosphere of it, is scarcely appreciably retarded.

With the view of ascertaining the best practicable combination for ordinary disinfecting purposes, I have for some time been engaged in a series of experiments on the value of various bodies for disinfection, as evidenced by their power of arresting putrefaction, of retarding the development of free-moving organisms, and of neutralising the results of decomposition. The details of these inquiries I hope to publish hereafter, when some of them, which are not yet quite completed, are finished. It will be sufficient to say that they are generally coincident with, and confirmatory of, the results arrived at by Dr. John Dougall of Glasgow,‡ in his lengthened and elaborate inquiries, and by Surgeon-Major O'Nial of the Army Medical Staff.§ The result of these experiments has led me to the conclusion that a combination of the aluminic and cupric sulphates with the potassic dichromate (producing in effect a potential cupric dichromate) possesses antiseptic powers of the highest degree, and is, at the same time, a most energetic coagulator of albumen, as well as a good deodorant, so far as sulphuretted hydrogen and ammonia are concerned. With this inorganic triad I further combine (mechanically) a small quantity of terebene (one of the isomers of oil of turpentine), a body which seems to have attracted little or no attention.|| This body possesses remarkable deodorant properties which are apparently due to its being an active ozoniser, which latter property is of itself in all probability owing to terebene

* To use liquid carbolic acid in quantity, as is generally done, is absurd waste: nineteen-twentieths of the acid are entirely thrown away in consequence of its slight solubility in water (about three per cent.)

† I have saturated with sulphurous acid gas solutions of decomposing organic liquids teeming with bacteria and vibrios, without apparently affecting them.

‡ On Putrefiers and Antiseptics, *Glasgow Medical Journal*, 1872-73; also paper read at Scottish Science Meeting, 1874.

§ *Army Medical Reports*, 1871.

|| The so-called "terebene" of the shops is a very different body: and, instead of being a substitution compound, is only an oxydised product of oil of turpentine.

* It is scarcely necessary to say anything of the worthlessness of such salts as calcic and sodic chlorides. As disinfectants—even as antiseptics—their action is very feeble, compared with that of numerous other available agents.

being a body in a state of very unstable equilibrium, and very prone to oxydation. The odour of terebene is far from being disagreeable; in mass it is somewhat terebinthinous, though quite distinct from that of turpentine, and is generally said to smell like oil of thyme or oil of cinnamon; but, when diffused through the air, in which condition it probably soon passes into incipient oxydation, it has an aroma quite peculiar, and not at all unlike that of fresh pine-wood, of the odour of which wood it is not at all improbable that terebene is the cause. At any rate, terebene possesses the same powers in a very active degree; and that it evolves ozone or else peroxide of hydrogen, may be shown by its producing the characteristic effect on tincture of guaiacum and blood-solution.

It is not inappropriate, in connection with this fact, to note that attention has lately been drawn by several writers, especially by Dr. Day of Geelong, Australia, to the ozonising properties of pine-wood, and to its value as a material for the construction of hospitals for infectious disease. In fact, Dr. Day attributes to it disinfecting powers of a high order. That it possesses very efficient deodorising properties, is within the observation of any one who has noticed the effect which fresh pine sawdust has on offensive masses; but that it is in any true sense a disinfectant is, for the reasons given above, I think more than doubtful.

To the compound above described, I give the name of *cupralum*. For crude deodorising purposes, where the coarser results of decomposition, such as sulphuretted hydrogen and ammonia, have to be neutralised, I combine a mixture of the sulphates of iron and alumina, with a mixture of carbolic acid and terebene. To this compound, which will be found effective for a variety of purposes, such as the deodorisation of drains, cesspools, urinals, etc., I give the name *ferralum*.

THE TEMPERATURE OF PHTHISIS.

By C. THEODORE WILLIAMS, M.D., F.R.C.P.,
Physician to the Hospital for Consumption, Brompton.

THE questions put to me on the temperature of phthisis by Dr. Edward Mackey, in the last number of the JOURNAL (February 13th), are of such importance, that I lose no time in replying to them, although I could have wished for a still larger accumulation of material than my 104 cases before I laid down definite laws on the subject.

Dr. Mackey asks for a further expression of opinion from me on the average frequency and character of the cases where tubercle forms without any rise or fall of temperature, and quotes some of Dr. Ringer's propositions: viz.: 1. There is probably a daily elevation of temperature in all cases where a deposition of tubercle is taking place in any organ; 6. By means of temperature (rise), we can in many instances diagnose tubercularisation long before physical signs were sufficient; 8. It is probable that, by means of the temperature (non-rise), we can conclude that the deposition of tubercle has ceased.

Of my patients, twenty-six were active first stage cases, in which no cavities existed, or any suppuration was proceeding, and the formation of tubercles was the only evident lesion. They thus, perhaps, afforded better opportunities of ascertaining the thermic phenomena accompanying tubercle formation than the more or less advanced cases to be found in a general hospital, and than Dr. Ringer's, in some of whom excavation had already taken place; for it is obviously of importance to exclude the phenomena of suppuration as far as possible.

In seventeen of the above twenty-six, a rise of temperature accompanied the formation of tubercle; the rise took place in the afternoon, invariably subsided at night, and was followed by normal or subnormal morning temperature. In some, the rise preceded the physical signs, in others it did not. In nine of the above cases (more than one-third), no rise was perceptible, though it was carefully watched for, the observations, as Dr. Mackey must have seen from my paper, being taken very frequently. In five out of the nine, subnormal temperatures prevailed, yet here the process of tubercularisation was traced day by day and step by step with the stethoscope; of these cases, two are narrated in my paper, one in which development of tubercle took place, and the other where a distinct extension of the tubercle-formation was detected.

These patients presented no striking clinical features, and their cases afterwards followed the course of chronic phthisis. The amount of consolidation seemed to bear no relation to the temperature. Five of the nine had one lung affected; four had both lungs involved. In one, active tuberculosis was taking place in both lungs. Some of the patients belonged to that category of cases where the early symptoms are so often mistaken for those of bronchitis, the tuberculosis being accompanied by wheeze and sonorous rhonchus, with frothy expectoration. All doubt as to the presence of consumptive disease was set at rest by

the appearance of subclavicular or suprascapular dullness. Valuable evidence confirmatory of my cases, and exhibiting the frequency of low temperatures in early phthisis, will be found in Surgeon Nathaniel Alcock's very able essay on the Nature and Varieties of Destructive Lung-Disease included under the head of Pulmonary Consumption (*Army Medical Reports*, 1873). My large opportunities at the Brompton Hospital have enabled me to collect and analyse the greatest number (as far as I know) of temperature-records of phthisis; and I do not hesitate to affirm that their evidence is not in accordance with Dr. Ringer's first and eighth propositions, nor, again, with this paragraph: "Admitting an elevation of temperature in all cases of tuberculosis and catarrhal pneumonia, it follows that, if the temperature be normal, we may conclude the patient is free from these diseases." Dr. Ringer's cases were, I believe, fewer than my own, and by no means so free from complications; but I do not doubt that so competent an observer, if he had had the same field for watching early phthisis, would have arrived at much the same conclusions on this subject as myself.

The old idea, that the formation of tubercle is invariably accompanied by rise of temperature, is untenable; and the question arises, in cases where high temperature is present, whether it may not be caused by the presence of pneumonia set up by the tubercle rather than by the tuberculosis itself? If the whole temperature-course of phthisis, in all its forms and stages, be surveyed, it will be apparent that low temperatures are as much, if not more, a characteristic of the disease as high temperature; and, if Dr. Mackey require a temperature-test for tuberculosis, he will be more likely to find it in (1) the fall of temperature at night, (2) low records of the early morning; or, when a rise takes place, not in the fact of the rise, but in the period in which it takes place, viz., in the afternoon, and in the rapid fall of the temperature towards night.

As I have recently laid a considerable mass of evidence on the subject before the profession in my paper read at the Royal Medical and Chirurgical Society on January 26th, and as I am preparing another, dealing with the effects of various accompaniments of phthisis on the temperature, I will not trespass further on the space of the JOURNAL. The joint work on *Pulmonary Consumption* by my father and myself contains little mention of diagnosis by temperature; for, at the time of its publication, my results had not been obtained; but, in a future edition, the question will be duly discussed.

PRELIMINARY NOTICE OF EXPERIMENTS ON THE PHYSIOLOGICAL ACTION OF JABORANDI.

By J. N. LANGLEY, B.A., St. John's College, Cambridge.

DR. FOSTER, having received from Dr. Ringer, through Mr. Martindale, a small quantity of the alcoholic tincture and glycerine solution of the alcoholic extract of jaborandi, placed the drug in my hands, and requested me to observe its physiological action. I have been able to make some observations, which are confessedly very incomplete; but I am induced to publish them, since they seem to have some interest, and because I shall be quite unable to resume them until after the close of the term, it being practically almost impossible for me to pursue any serious investigation while the class-teaching is going on.

1. *Effects on the General Nervous System.*—Injected beneath the skin of the frog, jaborandi causes tetanic convulsions not unlike those of strychnia. These continue when the brain has been removed, but do not appear after destruction of the spinal cord. The mechanism of their production is, therefore, not peripheral, but central and spinal. In two dogs which had previously been placed under the influence of morphia, and in two rabbits to which chloral had previously been given, no such convulsions were observed. The difference between the frog and the mammal may have been a question of dose. To settle this, further observations are necessary. I could find no marked effect on the irritability of the motor nerves or of the muscles; but on this point, also, I speak with reserve.

2. *Effects on the Circulation.*—In the dog (under morphia) and in the rabbit (under chloral), injection of jaborandi into the jugular vein was followed almost immediately by a distinct slowness of the pulse-rate. No initial quickening (Dr. Ringer observed quickening of the pulse in the human subject) was observed. This, again, may be a question of dose, and of rapidity of entrance into the circulation. The pulse was brought down to as much as one-third of its previous rate. The effect in the case of the rabbit came on very rapidly, soon reached a maximum, and then speedily diminished.

During the height of the effect, stimulation of the pneumogastric