cases of syphilitic paraplegia, they too expressed the greatest confidence in bichloride of mercury as a cure for paraplegia. But others happened to give it in succession to two or three cases not syphilitic in nature, and they declared it to be useless, or worse than useless, as a cure for paraplegia.

One mode, then, of estimating the value of therapeutic agents, may be called the individual; and, in testing the value of particular modes of treatment, members of this Society generally may assist. The other mode of estimating the value of therapeutic agents may be called the analytical; that is to say, we test the worth of the drugs by the analysis of a large number of carefully observed and recorded cases. For cases thus collected to be compared, they must be numerous enough to afford a sufficient number more or less identical in regard of age, etc. Researches of this kind can only be conducted in hospitals; and I think, for the purpose of collecting such cases in sufficient number, for the purpose of directing attention to special comparable facts, committees might be formed from members of this Society; and, were this done with due care, every member of the Society might aid in obtaining valuable, because real, therapeutic knowledge. And the testing clinically the value of the several remedies proposed by great authorities for the cure of acute rheumatism and of whooping-cough seem to me to be objects worthy of such a committee, and the questions involved seem to me to be those that such a committee might in time definitely answer.

Excuse me yet a little while, whilst I speak of the treatment of a special class of diseases. When any acute specific disease is epidemic, the educated public call loudly for a cure, and too often, I think, the members of our profession call out as loudly "Eureka!" Now, to me it seems that there are no grounds for expecting that a cure will ever be found for diseases of this class; that is to say, for expecting that a drug or medicinal agent will be discovered capable of arresting the progress of the organic changes which, set in motion by a special cause, following each other in definite and ascertained order, constitute what we call an acute specific disease; for, in place of being diseased actions, these several organic changes, the evidence of which we call symptoms, are, so far as our present knowledge extends, processes, the first of which being called into action by some external cause (for example, the poison of the disease), are essential for the restoration of the intimate organic changes to the order and intensity which constitute health. I may illustrate my meaning thus. Each of these diseases may be likened to a single fit of ague. We administer drugs to prevent the recurrence of the fit, but we do not cure the fit itself. The cold stage having commenced and attained a certain intensity, the hot and sweating stages are essential to the restoration of the balance of health. So with small-pox. By vaccination we prevent its occurrence; but, when the first of the phenomena—which, following each other in certain and definite order, constitute small-pox—occurs, we know that there is no road to health but by the sequence of changes, the symptoms of which mark the several stages of the disease; and it is to my mind very questionable whether, if it were possible by administration of a drug to arrest the essential changes which constitute any one of these stages, health would be the result. What is true of small-pox in this particular, seems to me to be equally true of all acute specific diseases; and when I read the list of cures for cholera which swarm in the columns of the press at the first inroad of an epidemic of that disease, I should smile, did I not know that a column of cures for cholera in a leading newspaper may be the death-warrant of numbers. Although the science of medicine can never hope for a cure for any one of these diseases, it can prevent death from all, and it is time that the public, and not the profession only, had correctly appreciated what medicine can and what it cannot be expected to do, in this class of diseases. Nor would medicine as a practical science fail in public estimation, or the physician be less highly esteemed, were the public instructed in the matter rationally. At one time, the chemist was valued especially, because it was supposed that, by his aid, baser metals could be transmuted into gold—"baser", as they were foolishly called; and day and night he sought for that "power of projection", as it was called, by which the transmutation could be at once effected. Faith in this transmutation, faith in the discovery of this powder of projection is exploded; but is the chemist less highly valued, his aid less earnestly sought? No. The work he can do is of more worth than the work it was fancied he could do. So with the physician; he cannot transmute by a special drug the sequence of processes which we call an attack of cholera into the sequence of processes which we call health, any more than the chemist can transmute iron into gold. The "certain cure for cholera" and the "powder of projection" of the alchemist are alike apocryphal; the dreams of a prescientific age, or the base attempts of charlatans and quacks to prey on those whose minds are yet in the prescientific stage of development; that is to say, on the ignorant and the credulous. The public must learn that the

true, the real in regard of the relation of medicine to these diseases is as different and as superior to the fancied as is chemistry to alchemy, or natural science to the black art. Medicine teaches us how to prevent in many of the acute specific diseases the first of those processes, the sum and sequence of which constitute the disease; and, when the first of that sequence has commenced, the physician, though he must reprobate the folly of those who cry out for a drug which will stay the sequence of processes which are in reality steps to health, does not stand helplessly by and leave the patient to his fate; but, by the judicious application of the rules of art, so moderates the necessary disturbances of formation, that they shall eventuate, when the last of the series of restorative processes is over, in health in place of death. The physician in such cases may be likened to the physicist who, although he cannot prevent the discharge from the electric-laden cloud, can yet save the threatened tower by conducting the lightning-flash harmlessly to the earth.

LECTURE ON COMPARATIVE PHARMACOLOGY AND THERAPEUTICS.

Being part of an Address delivered at the Manchester Club of Aberdeen Medical Graduates.

By JAMES ROSS, M.D., Waterfoot, near Manchester.

THE physician has to do primarily with functions, and, secondarily, with structure; and it may be thought that molecular physics, including chemistry, has made such rapid strides of late years that it will afford, along with physiology, as secure a basis for his treatment as molar physics along with morphology does for that of the surgeon. But this is not the case. The effects produced upon organisms of all kinds by bodies in mass, is much better ascertained than those produced by the molecules of substances circulating in the fluids of the body. And this lack of knowledge of the effects produced by the molecules of substances which gain entrance into the circulation, constitutes the greatest gap in our knowledge of the sciences which form the immediate basis of treatment. But even this gap is being rapidly filled up. I am not an old member of the profession, yet my text-book on the subject which treats of drugs and of their actions, which was a closely printed octavo volume of about 800 pages, and which was full of all sorts of information respecting the drugs themselves, gave only the most scanty information with regard to their action upon the body. The only information which it contained with regard to the action of such a commonly used and useful drug as bicarbonate of potash was, that it was "antacid, antilithic, diuretic, and resolvent", and it gave no fuller information with regard to the action of any other drug. Things are somewhat mended since then. We have such works on *Materia Medica* as that of Nothnagel in Germany, Rabuteau in France, Dr. Wood, jun., in America, Dr. Sydney Ringer, and a first instalment of a work by Dr. Charles Phillips in this country. I have not yet seen Dr. Wood's work, but I am told that it is very accurate, and contains a vast amount of information respecting the action of drugs. I can, however, speak from a personal acquaintance of the other works which I have mentioned, and I must say that each and all of them are immensely superior to the treatises which were in existence during my student days. But, notwithstanding these works, much requires to be done before a scientific basis is given to drug-treatment. In every department of knowledge, the systematic application of the comparative method is that which has given the most valuable results to the scientific workers of the present day. The science of comparative anatomy, or more correctly of comparative morphology, has been constituted within the memories of many living; while the foundations of comparative physiology, comparative psychology, and comparative philology, have been laid by our own contemporaries; and even now comparative theology is pressing itself upon our notice. And, to give a scientific basis to drug treatment, we must found the science of comparative pharmacology. We want to discover a general body of formulæ, which shall be true not simply respecting the action of drugs upon this or upon that organism, but respecting their action upon all organisms whatsoever. And if our facts were fitly arranged for the application of the comparative method, many such formulæ could be readily obtained; indeed, a glimpse may be got of a few of these formulæ even with our present arrangement of the facts. Take, for instance, any one agent, such as ethyl-alcohol, and compare its action upon different organisms. Alcohol

checks the movements of protozoa like the amœbæ, and kills them without producing any other symptom. Leaving out of account its action upon vegetables, not because it is important, but because so little is known respecting the action of drugs generally upon them, let us administer it to an animal a little higher in the scale than the protozoa. When it is given to one of the articulata, for instance, there are no marked contrasts between the action it produces upon various parts of the body. It kills by an almost simultaneous suspension of all the functions. When, however, it is administered to one of the vertebrata, the effects produced, both simultaneous and successive, are very varied and multiplied, and the multiplication and variety of effects reaches its height in man. The effects produced upon the human organism need not be described in detail. The experiments which we ourselves are carrying on with this agent at present, sufficiently demonstrate that its effects upon us are more multiplied and varied, in one word, more heterogeneous than the simple homogeneous effect it produces upon amœbæ; although I make no doubt that, if we carry our experiments sufficiently far, alcohol can check our movements as it does those of the protozoa. But as we proceed from the lower to the higher organisms, not only do the effects produced become more heterogeneous but they become more special. This is as true of other agents as of alcohol; but, in the case of the latter, the special effects produced upon the nervous system are so pronounced as to obscure its other effects. To account for this speciality of effect, it has been assumed, that alcohol has a special affinity for nervous tissue, but there is no reason to make this assumption. Alcohol is a very indifferent substance, having chemical affinities of narrow range; and, since it enters into no strong chemical unions without the body, there is no reason to believe that it will exhibit strong affinities within the body. And, moreover, it checks the amœboid movements of the white blood-corpuscles and the movements of the cilia of the bronchial mucous membrane, showing that much of its action is independent of the nervous system. Various reasons might be given to explain why an agent, which acts indifferently upon all tissues, should yet produce a more special action upon one part of the body than upon another; but a few of these must suffice. It is probable that no agent can act until it comes into contact with the protoplasm of the tissues; and, in some tissue, the intercellular substance is so dense, that even a diffusible agent like alcohol would take a long time in gaining access to the protoplasm, while it would gain ready access to the protoplasm of such a delicate structure as that of the nervous tissue. And, from the nature of the function of nervous tissue, a very slight interference with its structure will produce a large and manifest effect upon function; while a very considerable interference with the structure of passive tissues, like bone and tendon, and even most mucous membranes, will produce a very inappreciable effect. And, again, the more freely an organ is supplied with blood, the greater the proportion in which an indifferent substance, like alcohol, circulating in the blood, will be supplied to it; hence an organ performing a very active function will have a greater amount supplied to it than one performing a less active function. These considerations show that, as we proceed from the lower organisms to the higher, not only does the action of an agent become more heterogeneous, but also more special, even if the agent itself is a perfectly indifferent substance, acting in a similar manner upon all living tissues whatsoever.

I have already spoken of the value of embryological studies, and I will now show that such studies tend to throw a considerable amount of light upon the action of medicines. The embryo-cell is almost homogeneous in form and chemical composition, but, when developmental changes begin after fertilisation, this condition soon gives place to a heterogeneous arrangement of parts, which is accompanied by a heterogeneous disposition of chemical elements. Some of the salts of lime become deposited in one part, those of iron in another, and phosphorus in a third. There is no occasion to believe that each of these elements had a special affinity for the tissue on which it has become deposited. The specialisation of structure in each of these tissues has been preceded and caused by specialisation of function. When, however, a specialisation of function has produced a modification of structure, a capacity for performing the function becomes developed in the tissue, and this reacts upon the function, and renders a further specialisation of it possible, which, in its turn, produces a further modification of structure. And, accompanying this modification of tissue, there is a corresponding modification of chemical constitution or of composition, or of both; the differentiation of chemical composition being slight when the differentiation of function is slight, and profound when the differentiation of function is great. There can be no doubt that the deposition of phosphorus, and of the salts of lime, iron, and other elements, which are not found in ordinary albumen, was a necessary condition of the differentiations which result from the action and reaction between structure and function; but it is not necessary for us to assume

that each of these elements had originally a special affinity for the tissue in which it is found. When, however, differentiations of chemical composition have once been produced, they will lead to specialisations of chemical action, if heterogeneous agents are introduced into the blood. Like will gather to like, and when an agent cannot find its like, it will select that part of the body which is most similar to it.* In this way we find that the compounds of the chemical agents, which have massive atoms, act principally upon the dense parts of the body; whilst those of the least massive atoms, act upon the parts of the body which have a delicate structure, such as muscle and brain, and probably also upon the blood. We know that the salts of iodine, mercury, silver, lead, and of the metals generally, act upon the bones, tendons, and cellular tissue; those of potash and soda upon muscle; those of carbon and the gaseous elements, principally upon nervous tissue. This also explains why the compounds of the elements, having massive atoms, are eliminated by the bowels, those of the elements, with atoms of medium mass, by the kidneys, and volatile substances principally by the lungs, and partly by the skin.

The embryological law, which was first formulated by Von Baer, may be modified so as to be applicable to the action of medicines. The law is that, in its earliest stage, every organism has the greatest number of characters, in common with all other organisms, in their earliest stages; that, at a stage somewhat later, its structure is like the structures displayed at corresponding phases, by a less extensive multitude of organisms; that, at each subsequent stage, traits are acquired which successively distinguish the developing embryo from groups of embryo which it still resembles; and that thus the class of similar forms is finally narrowed to the species of which it is a member.† This law, which is true of structures, is equally true of functions, and the likenesses and unlikenesses which it asserts respecting the structures of organisms during their development, are also true respecting the reactions of these organisms to the action of drugs. The law may be modified in the following way. The action of any drug upon an organism in its earliest stage is similar to its action upon all other organisms in their earliest stages; its action upon the same organ at a somewhat later stage of development, is similar to that which it produces at corresponding phases upon a less extensive multitude of organisms; at each subsequent stage, peculiarities of action become manifest, which successively distinguish that produced upon the developing embryo from that produced upon groups of embryo, which it still resembles; and, lastly, the action produced upon the organism displays peculiarities which narrow the similarity to that produced upon the species of which it is a member.

Our facts might also be arranged so as to facilitate a comparison of the effects produced not by one agent upon different organisms, but by different agents upon one organism. The embryological law, already noticed, taught us that the actions produced upon different organisms are similar when the organisms are similar, less similar when the fundamental likenesses between the organisms are less, and only remotely similar when the likenesses between the organisms are small. We now come to the obverse of this law. The actions produced upon

* When I gave expression to this law, I was not then aware that M. Coze of Strasbourg had anticipated me by upwards of thirty years. He draws the following conclusions from his experiments. 1. That volatile substances introduced into the system have a tendency to be eliminated by those organs which, in a physiological state, secrete gases or vapours—the lung and skin, for example. 2. That substances which contain principles the same as those which naturally form part of a secretion are eliminated by the organs which furnish this secretion. 3. That substances which enter into the composition of an organ, when given as medicines, are carried to that organ. 4. That among the substances which do not naturally enter into the composition of the solids or fluids of the animal system, there are some whose action obey what may be called their general chemical character; thus acid substances are eliminated by acid secretions. (See *American Journal of Medical Science*, April 1843, p. 438.)

† Nor was I aware then that M. Gubler has recently enunciated a similar law. He maintains that—1. Substances, when absorbed, tend towards their similars or analogues; 2. When a substance cannot meet with its similar or analogue, it must be eliminated; 3. It is eliminated by the channel in which it meets with similar bodies. (See the *London Medical Record*, December 23rd, 1874.)

‡ In the text, I have availed myself of Mr. Herbert Spencer's expression of this law (*Principles of Biology*, vol. i, p. 142). Von Baer's laws are the following.

"1. Dass das Gemeinsame einer grössern Tiergruppe sich früher im Embryo bildet, als das Besondere.

"2. Aus dem Allgemeinen der Formverhältnisse bildet sich das weniger Allgemeine und so fort, bis endlich das Speziellste auftritt.

"3. Jeder Embryo einer bestimmten Thierform, anstatt die andern bestimmten Formen zu durchlaufen, scheidet sich vielmehr von ihnen.

"4. Im Grunde ist also nie der Embryo einer höhern Thierform einer andern Thierform gleich, sondern nur seinem Embryo." (*Ueber Entwicklungsgeschichte der Thiere, Beobachtung und Reflexion*, von Dr. Karl Ernst v. Baer, Erster Theil, 1828, S. 224.)

These laws, however, when separated from the discussion which precedes and follows their enunciation in Von Baer's work, do not give a complete embodiment to the conceptions intended to be conveyed; but the laws are of more than passing interest, since they are the germs from which sprang much of what is characteristic of the philosophy of Mr. Herbert Spencer.

similar organisms by different agents, are similar when the agents themselves are similar in chemical and physical properties, and the likenesses between the actions become less and less as the agents become removed from each other in their fundamental properties.*

At the meeting of the British Medical Association this year, at Norwich, I proposed, in a paper "On the Action of Mercury," two laws of the action of medicines. The first is that, other things being equal, the more massive the atom of the element the more definite and local will be the action of its compounds; and the second that, other things being equal, the greater the molecular mobility of an agent, the more general and diffused will be its action.† These laws frequently coincide, yet the one is not the converse of the other. Mercury, for instance, is an element with massive atoms, hence the action of its compound should be local and specific; but it possesses great molecular mobility, since it volatilises at ordinary temperatures, hence it should exercise a wide and diffused action upon an organism. Reference to observed facts shows that, although the action of mercurial compounds is specific, yet it is of wide extent. In the light of these laws, the experiments of my friend and old fellow-student Dr. McKendrick of Edinburgh, in association with Mr. Dewar, upon the chinoline and pyridine series of bases, possess the utmost significance. These compounds could, at one time, only be obtained by distilling natural alkaloids, such as strychnine and quinine, with caustic potash; but chemists now form them from coal-tar.

Mr. Dewar, who is the chemist, forms the compound, and submits it to Dr. McKendrick, who determines its physiological action. Chinoline, which has a composition of C^9H^7N , and boiling point of 238° , has an action somewhat similar to that of chloral; but, as we ascend in the scale, the action upon the sensory part of the encephalon is becoming less marked, and that upon the motor centres more manifest, until the higher members of the series ($C^{16}H^{21}N$, with boiling point above 300°) produce death by convulsions and subsequent paralysis, not unlike the action of strychnine. As the molecule of the agents is becoming more massive, the action is becoming more special and local; the higher part of the brain being left unaffected at first, then the lower ganglia, until at last we have almost the pure action on the cord itself.

It would be interesting and instructive to make comparative experiments upon the action of the alcohols to see if they conform to a similar law.‡ The little we know of the action of different alcohols gives indications that such is the case.

The action of methyl is more diffusible than that of ethyl-alcohol. Nothing much is known respecting the action of propyl-alcohol; but Scotchmen know that when a man gets drunk upon new raw whiskey, which contains a considerable percentage of amyl-alcohol, the effect differs considerably from that of drunkenness from more or less pure ethyl-alcohol. There is less blunting of the intellectual faculties, and a more profound disturbance of the lower emotions, such as rage and jealousy, and I think I am right in saying that a poisonous quantity of such a compound is apt to produce convulsions. It is very probable that the difference which Dr. Magnan of Paris has shown to exist between the action of absinthe and that of ordinary spirits is one of this kind, and depending upon the presence in absinthe of an alcohol with a higher chemical composition than that of ethyl-alcohol. A comparison of the action of the various alcohols suggests to the mind the operation of another law. The monatomic saturated alcohols are poisons, the diatomic alcohols or glycols are less poisonous, the triatomic alcohols or glycerines have a still less effect, and when we come to the tetratomic, pentatomic, and hexatomic alcohols, we obtain substances which are either inert or are foods. This may be an example of the law that, other things being equal, the more heterogeneous a substance is to the body, the greater will be its effect. The hexatomic alcohols or glucocides are homogeneous with the body, and, therefore, will act as foods; while the monatomic alcohols are both physically and chemically more heterogeneous to the body than any of the intermediate alcohols. The reason why the hexatomic alcohols act as foods while the alcohols with saturated radicals act as poisons, is probably that the former are less stable than the latter, and consequently undergo with readiness transformations within the body, whereby force of some kind is evolved. A more

or less parallel fact may be noticed with respect to inorganic substances. The elements which are classed as irritants are, as a rule, either univalent or bivalent; while the substances called tonics are generally either trivalent or some higher degree of atomicity. This law has a sufficient number of exceptions to show that the irritant or tonic properties must depend upon other conditions than the atomicity of the agents. Another law is that, other things being equal, the greater the molecular mobility of an agent, the sooner it gains entrance into the body through the absorbing surfaces, and the sooner it is eliminated. This law explains why nitrous oxide gas acts more rapidly, but more evanescently, than ether, and ether than chloroform, and chloroform than chloral. Closely related to, although not the converse of, this law is the one, that the compounds of the elements with massive atoms are relatively long in gaining entrance into the circulation through the absorbing surfaces, and are correspondingly long in being eliminated; and when the agents form, like the metallic salts, stable compounds with albumen, the length of time before they are eliminated is much increased. Another law is that, other things being equal, in binary compounds both elements are represented in the effect produced, but the action of the heavier atomized element will predominate. Take, for instance, chloride of potassium, bromide of potassium, and iodide of potassium. In the first, the action of both elements is represented, but that of the potassium predominates; in the second, the action of the bromine predominates, but when an animal is poisoned by bromide of potassium, the action of a potash salt upon the heart is apparent; while, in the third, the action of the iodine largely predominates. The action of this law may be traced through compounds of a higher grade than the binary. When, however, an agent produces a very energetic effect, such as hydrocyanic acid, it makes its influence predominate even in composition with the more massive atomized elements. We can promise a rich harvest to any one who will have the patience to differentiate by experiment the physiological action of the various chemical groups of organic compounds, and who will then contrast with each other the actions of the groups themselves; such as that of the hydro-carbons, alcohols, ethers, acids, aldehydes, ketones, amines, and amides, and passing through the remarkable bases which I have already mentioned—the chinoline and pyridine series—to the natural alkaloids.

These laws belong to a general science of pharmacology. They are as true of the action of medicines upon all organisms, especially all animal organisms, as they are of their action upon man. They are, however, too remote from practice to be of much immediate use. More specific laws must be discovered before a great effect is produced upon practice; and, to do this, we must proceed in a systematic manner with the arrangement of our facts. We must first of all possess a descriptive pharmacology, which must be freed as much as possible from all hypothesis. I think myself that, if we were to arrange all the facts known respecting the action of medicines upon different organisms in tables similar to the plan adopted by Mr. Herbert Spencer for arranging sociological facts, a great deal might be done in a few years to reduce the actions of medicines to a complete systematic form, which would afford a good scientific basis for the treatment of disease by drugs.

I must now bring these remarks to a close. I have already pressed much too long upon your patience; but, before sitting down, I will endeavour to enforce one or two practical rules with regard to teaching. It is evident that no student can acquire a real knowledge of all the subjects I have mentioned in four years. In making a choice of subjects for his study, we must fall back upon the rule I have already laid down. He must have a minute and accurate knowledge of the subjects which immediately underlie practice; and the teachers of the subjects which bear only remotely upon practice should be careful not to burden the student's mind with too many details. It is perfectly possible for a student to have a good grasp of the fundamental principles of botany, zoology, and even chemistry, without the mind being burdened by a too minute recital of facts. And, if this rule be necessary for the teacher, it is doubly necessary for the examiner. It would be a great pity to reject a student who is well qualified to make a sound practitioner because he cannot tell the natural family of the castor-oil plant.

The only other remark I would make with respect to teaching is, that the student should be brought as much as possible, and as early as possible, into contact with Nature for himself. He must be taught to be independent of teachers. A medical man is, before all, a man of action, and he should not be a passive recipient of the sayings and doings of others; but he should be encouraged to employ himself actively in the study of science. A man must first woo Nature before he endeavours to master her in her erring moods. Hence, a student should spend much of his time in the dissecting-room, the museum, the chemical and physiological laboratory, and, above all, in the dispensary and the medical and surgical wards and *post mortem* room of a good

* In connection with this law, I ought to mention the names of Drs. W. H. Broadbent, Crum Brown, and Thomas Fraser, in this country, and Jolyet and Cahours on the Continent. (See the *London Medical Record*, Dec. 23rd, 1874, p. 809.)

† Rabuteau has recently enunciated the law, that metals are more active, physiologically, according as their atomic weights are higher or their specific heats are lower. The monatomic metalloids are governed by a law which is the reverse of this. The metals rubidium, tungsten, and molybdenum are exceptions to the law. The differences between this law and mine are sufficiently obvious not to require pointing out. (*London Medical Record*, Dec. 23rd, 1874.)

‡ Dr. Benjamin Ward Richardson has drawn attention to the fact, that the number of atoms of carbon contained in an alcohol appears to serve as an index to its activity, as may be seen by comparing the respective activities of ethyl and amyl alcohol. (See *London Medical Record*, December 23rd, p. 810.)

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-