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AN ESSAY

ON THE

Cause, Diffusion, Localization, Prevention and Cure

OF THE

ASIATIC CHOLERA

AND OTHER EPIDEMICS.

By WILLIAM SCHMŒLE,

Doctor of Philosophy and Medicine.

FOR SALE BY

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CONTENTS.

PREFACE.

FOR more than twenty years, the author of this Essay has endeavored to trace the causes of epidemic diseases, by analyzing, comparing, and weighing, in the light of modern physical science, the various effects of such causes and the circumstances under which the effects are produced.

The first results of this study he was, while on a scientific tour through Europe, invited to lay before a highly scientific body, the German Medical Society of Paris, which he did in the month of March, 1846, in a "Discourse on the Nature and Origin of Infectious and Epidemic Diseases."

When, in the beginning of this discourse, the author announced that he believed to have traced all infectious and epidemic diseases, sufficiently, to their respective causes, to understand the *modus operandi* by which those diseases are produced, and to develop general principles for their prevention and final extinction, a smile of incredulity was visible on the countenances of most of the learned doctors and professors present on that occasion.

This was not unexpected; and the author expressed his desire to have every position taken by him strictly criticised, because he did not wish either to be himself deceived or to deceive others. Thereupon, most of the gentlemen took notes, and the subject-matter of the discourse was freely discussed in several subsequent sessions of the Society. The final verdict was a general acquiescence in the theories advanced.

During the preparation of that discourse, and more

during its discussion in the Society, two important obstacles were found to be in the way of a universal appreciation of the deductions of the author, which obstacles, he is sorry to say, are still more or less obstructing the road to a clear view of the nature and causes of epidemic diseases. One of these obstacles was, that, at that time, chiefly on the authority of Liebig, notwithstanding the clear and conclusive experiments of Schwann, the minute processes of nature, resulting in the decomposition of animal and vegetable substances, viz., putrefaction and fermentation, were attempted to be explained on purely chemical principles. Now, it had occurred, not only to the author, but to many inquirers, that there is a great analogy between the manner of production and development of those minute processes mentioned, and of epidemic diseases. So strong was the impression of that analogy, that epidemic diseases have, of late, been generally comprehended under the term of "zymotic" diseases, from the Greek word "zymöo," I ferment.

Inasmuch, therefore, as the processes resulting in the production of epidemic diseases were partly to be explained by their analogy with the processes of nature, resulting in putrefaction and fermentation, it was necessary, first, to disprove Liebig's purely chemical theory, and to vindicate Schwann's clear and beautiful explanation of these processes, which is now universally, at least practically, admitted. Nearly all the modern methods of preserving animal and vegetable substances have their scientific basis in Schwann's experiments. Still the great value of Schwann's doctrine for explaining, by analogy, some of the processes concerned in the production of epidemics, appears not yet to be appreciated. In the succeeding essay this analogy is applied.

The second obstacle, which prevents an unclouded view into the causality of epidemics, is not only the still prevailing general darkness in the field of pathology, but also certain *ignes fatui*, or singular physiological absurdities,

which still lead the medical world into many miry places of theory and practice. A real science of pathology cannot be said to exist, while the assertion may be made that not a single disease has, as yet been scientifically explained. Even the cellular pathology of Virchow, in which most of the modern pathological inquiries have culminated, is only an approximation to an outside view of the finer pathological processes, which leaves us as wise, regarding the laws on which those processes depend, as the cellular theory itself has only removed the physiological question of the laws of the vital processes some steps nearer to, not into, the field of vital chemistry. One *ignis fatuus*, or fatal error, in pathology, as at present prevailing, is the tendency to localize nearly all diseases, *prima facie*, in the blood. "Impurities," or a "taint," or a certain "diathesis," or "crasis," of the blood must account for nearly every ailment.

Eruptions on the skin are uniformly ascribed to supposed impurities of the blood, although it is impossible to find any power in our body by which such impurities, if they existed, could be separated from the blood, and carried on the surface, to appear in the various shapes and forms, in which eruptions may appear. To show, in a striking manner, the absurdity of considering locally circumscribed diseases as resulting from any supposed alterations of the blood, a short dialogue, that happened between a distinguished professor of pathology and the writer, may here find a record.

The professor had taught much about "blood crases," to which the writer took exceptions, denying that any *locally limited* disease could be caused by such a "crasis." As a type, the most serious of such supposed blood diseases, *cancer*, was made the subject of the following short discussion:

PROF. How can you deny that cancer is the result of a cancerous crasis of the blood, since you have seen, with me, so many cancer cells in the blood of corpses in which we found developed cancers?

WRITER. Suppose I grant, for the sake of the argument, that cancers are formed of cancer cells previously existing in the blood. Now you tell me, how they get out of the blood to the localities in which we find them?

PROF. (After a short reflection.) You are right. Cancer cells are as large or larger, than the blood corpuscles. Consequently they could not pass through the walls of the blood vessels, to be anywhere deposited, even if a disposition for so doing existed. The cancer cells which we and others have found in the blood of persons afflicted with cancers, must have been formed in the cancerous locality, and carried into the venous circulation by the partial destruction of the walls of some veins involved in the local cancerous process, etc.

Another *ignis fatuus* of pathology is the yet prevailing singular and mysterious tendency of ascribing to purely physical processes teleological objects or *mental aims*. Thus we still read and hear, on all sides, much of the beneficent acts of the fabulous "*vis medicatrix naturæ*," or "healing power of nature," as if the disease-creating power belonged to something or somebody outside of nature. Nature is represented as "the greatest physician," whom the medical men must "imitate," or "assist," as if diseases came not from the same nature, but from something or somebody else whom we must abhor. The blood is viewed as an intellectual but very arbitrary being, which, in its circulation, acts on freaks and impulses, not on the fixed laws of hydrostatics. "Wherever there is an irritation, thither it rushes," "*ubi irritatio ibi affluxus*," although a doctrine of the innocent age of the childhood of medicine, and in direct opposition to the laws of hydrostatics, is still the theme of nearly all of our medical savans. Of a "determination" of the blood to the head, or any other part, of "active congestion," of "excessive vascularity," or of "a want of circulation," of a "chill of the blood," or of an "overheated" or "over-excited" state of the blood, etc., we read nearly on every page of medical works. The various organs and

parts of the body are supposed to be endowed with autonomous powers of "reaction," or of "revulsive action," against the assaults of foreign influences, by virtue of which they may institute such processes as are intended for their protection and preservation. These and innumerable similar *mythological* notions are so deeply rooted in the medical profession, that but few inquirers are able to shake them entirely off, and pursue their medical studies under the application of purely physical laws.

This regard for old doctrines, which permits no search for the proximate cause of epidemics but in the state of the blood, and for the remote cause but in influences of supposed relation to the blood, will scarcely lead to the discovery, nor easily allow an appreciation, of the simple physical laws of epidemics deduced in the following essay. Confident of their truth, however, he has published them, first by the above-mentioned discourse, then by communications for various periodicals, and by lectures before medical students, and he ventures now upon their publication in this more practical than theoretical essay, leaving their thorough scientific and systematic elaboration for a larger future work, which he is preparing.

INTRODUCTION.

In the medical, as in other physical sciences, we have two main sources of knowledge, viz.: *direct observation* of objects appreciable to our senses, and *logical deduction* of the nature of other objects inappreciable to our senses, but which may be known by some of their essential qualities.

Although direct observation may be said to be the most certain and reliable source of information, there may be, and frequently are, cases in which logical deductions lead to more definite and much more applicable knowledge, than we obtain by the mere use of our physical senses.

Indeed, direct observation has, in many instances, led to erroneous conceptions of realities, which could only be corrected by the critical and exact application of logical deduction. Thus has mankind, for thousands of years, relying on direct observation, believed that the sun takes his diurnal march around the earth, etc., until logical deduction proved the rotation of the earth around its axis, and constructed the magnificent system of astronomy, which is now the pride of human intellect.

Direct observation had taught, for ages, that certain tubes in the animal economy were filled with blood, which, therefore, were named "veins," or layers, upon which we *come*, in dissecting, (from the Latin verb *venio*, I come,) like similar layers, or "veins," of ore, found in the body of the earth; and that other tubes found more or less empty, in dissections, were filled with air, which were, therefore, called "arteries," *i. e.* air holders, (from the Greek words *aër*, air, and *tereo*, I hold or contain,) until Harvey, within the last two centuries, proved, by logical deduction, that the blood *circulates* through the body, and that the blood found in the veins is only that passing portion of the whole

which is returning to the heart, and that the supposed air vessels, or arteries, do not hold air, but the other passing portion of the blood, which is coming from the heart. The knowledge thus gained led to an entire reformation of the medical sciences. Yet, so great was the devotedness of many physicians to the old doctrine taught by Galen and others, that one exclaimed, he would prefer remaining in ignorance with Galen, to being "a circulator" with Harvey. (*"Malo cum Galeno errare quam cum Harveyo esse circulator."*)

Although the knowledge of the circulation of the blood had led to extensive and minute researches in the anatomy of the blood-vessels, no direct communication between the finest observable branches of the arteries and veins was found. Hence it was supposed that the arterial blood was diffused through the tissues of the body, as a river may be lost in a sandy plain; and that the blood from such general diffusion found its way again into the veins, as the water is collected in the earth into springs, rivulets, etc., and finally into larger streams or rivers. Logical deduction, however, proved that there must be an unbroken connection between the two sets of vessels, or an intermediate network of tubes which form a continuation of the finest arterial vessels to the finest venous tubes, before direct observation discovered, or rather corroborated, the knowledge of the existence of the capillaries.

A similar step of knowledge in the same direction, viz., a logical deduction of the distribution of *vascular nervous substance throughout the capillary network of blood-vessels*, the author was compelled to take, with others, in the absence of anatomical observation; nay, in opposition to the negative assertions of some distinguished anatomical authorities, based on the absence of direct observation of such nervous matter. The chief reason for assuming the existence of nerves in the system of the capillaries, is the uniform contraction of the capillaries upon direct as well as sympathetic irritation, attested by numerous experiments on living animal bodies, and by daily observation in

our own vital functions. Without such knowledge, the author found it impossible to arrive at any satisfactory explanation of the laws which govern the supply of nutritive substance for the various tissues of the animal body, both in normal and abnormal quantities or proportions. With this knowledge, and with the application of various well-settled chemical and dynamical laws, he was enabled, not only to lay the foundations for a new important science, *vital chemistry*, or *organo-chemical synthesis*, but also to trace the primary processes of diseases, and the progressive processes of their development; or, in other words, to lay the foundations for and build up a system of *demonstrative pathology*. Both sciences he has, for the last ten years, divulged by lectures before medical students, and he is now engaged in preparing a treatise of them for the press. The subjects of the following essay will, more elaborated, be embraced in that treatise. By the term of "demonstrative" pathology, he means to convey that he believes to have traced all essential laws of nature, concerned in the causation and development of diseases, with such clearness that they are capable of being demonstrated. Such, at least, has been his aim, and so far only as he may have succeeded in approaching that aim, he considers his accomplishments as being of value.

One of the most important achievements of modern science is the knowledge of the laws of putrefaction and fermentation of animal and vegetable substances deprived of life. This knowledge has been acquired chiefly by logical deduction from ingenious experiments first instituted by Schwann. If two pieces of meat are put in two bottles, each containing a little water, and both bottles being well corked; and if a glass or metal tube is led through each cork, one end being in the bottle, and the other end in the open air, but the outer end being closed by a stop-cock attached to it, near its termination; and if then both bottles are put into boiling water long enough to cause the water and meat within them to be boiled;

then both bottles may be placed in any locality, either warm or cold, and no putrefaction of the meat will take place. But if, in a *warm* room, the cork of one tube is opened for a short time, and thus a momentary communication between the outside atmosphere and the inside of the bottle established, the meat will begin to putrefy within a few days, and on it will be seen, by a microscope, great numbers of infusoria. If then the other bottle is similarly treated, but, before the stop-cock is opened, the flame of a spirit-lamp is held to the tube, between the stop-cock and the cork, to thoroughly heat the tube, then no putrefaction of the meat will ensue, and no animalcular infusoria will be found on it. Nor will any putrefaction take place if either bottle is treated like the first, in a *cold* place, say in winter.

From these and similar facts the following logical deductions are made:

Putrefaction takes place only on the development of animalcular infusoria on the meat, the seeds of which must be floating on the moisture of warm air. In a similar manner it is proved that vegetable putrefaction or decay results from the growth of mold, or cryptogamic plants, on dead vegetables, and that the seeds of those cryptogamic plantlets constantly float around us on the vapors of warm air. The causality of fermentation, as depending on the development of the "yeast plant" in the presence of fruit sugar, or other substance to be decomposed, is also similarly proved.

Neither *seeds* have ever yet been seen by direct observation; yet their presence in the vapors of warm air is proved by logical deduction, as stated. Having once gained the knowledge of their existence, we can favor or prevent their development or propagation at our option, by causing all the essential conditions of their growth and propagation to be present, or by removing one or another of those conditions.

The essential conditions of all organic development are the following:

1. The existence of parental organisms, or of living germs or seeds.

2. The presence of nutritive (albuminous) substance.
3. The presence of water.
4. The presence of free oxygen or air.
5. A certain degree of temperature.
6. Absence of overpowering disturbing influences.

All processes of animal and vegetable putrefaction and fermentation depend on the fulfillment of *all* those six conditions.

To prevent such processes, it is therefore only necessary to remove, as stated, one or another of those conditions. On this knowledge the *correct application* of the modern methods of preserving animal and vegetable substances depends. Also the various processes of "*deodorization*" have their only true basis in that knowledge. Here it may be remarked that all substances and processes which are successfully applied for deodorizing purposes are also used as "disinfectants."

Now, deodorization means nothing else than a method of checking odors arising from processes of putrefaction; désinfection (or disinfection) means a method of depriving infectious substances of their power of infection. In either case, the causes of the obnoxious processes are to be removed. Every agent found, by experience and observation, to answer either purpose, answers also the other; and they all agree in but one sensible, and therefore to be assumed, principle of action, viz.: that they remove the causes of either of the obnoxious processes by destroying them as minute living organisms. Besides various sharp salts, and other substances known to be poisonous for minute organic bodies, both animal and vegetable, we have *either extreme* of temperature, *i. e., excessive* cold and *excessive* heat (as compared with the requirements of minute organic life), namely, *cold* at and below the freezing point, and *heat* at or above the boiling point, of water, as sure deodorizers *and* desinfectants. If all these agents acted purely as chemical agents, and if the obnoxious processes against which they are applied were *purely chemical* processes, the

usual precise discriminations depending on the various chemical affinities would necessarily come into consideration, and require many modifications and variations of the agencies to answer the different substances and processes to be acted upon, and an *increase of heat*, the great promoter of chemical action, especially up to and above the boiling point of water, would be found to favor rather than to check most, or all, of the processes desired to be annulled.

Assuming, then, for the reasons given, that the causes of putrefaction and fermentation, and the causes of infectious diseases, are so far alike as to be both living organic bodies, the diversity of their respective effects may be explained in two ways: 1. The causes of putrefaction and fermentation may be so far different from the causes of infectious diseases, in *other* essential characters, as to be able only to exercise their influence on *dead* animal and vegetable matter, while the organic causes of infection may have the power of influencing the processes of living higher organisms; or, 2. The difference of the result of the influence of either may be merely incidental, *i. e.*, depending on the accidental presence of different objects of their influence, while and where their development takes place.

It will be made evident, as far as logical deduction at present may enable us to do so, in the following essay, that partly the one and partly the other explanation of the difference of result from the influence of either kind of causes is admissible. It will also be shown that the causes of putrefaction, which are surrounding us nearly at all times, are only prevented from acting on us as causes of serious infectious diseases by the fortunate circumstance that our vital processes, when we are in full vigor of life, belong to the class of overpowering disturbing influences, the *absence* of which has been stated as the sixth essential condition of the development of minute organisms. It will also be shown under what circumstances this protective influence may be lost in us, and in what way either cause may produce diseases in the animal body.

ON THE CAUSE, DIFFUSION, LOCALIZATION, PREVENTION AND CURE,

OF THE

ASIATIC CHOLERA AND OTHER EPIDEMICS.

Causes.

I.—The nature of a contagious or infectious epidemic disease involves that it or its cause is capable of propagation, by the reproduction of the cause. No matter whence originally the cause of such disease may have come, as soon as one person has been thereby infected, the same cause, or at least the same kind of cause, will be reproduced in, or on, the patient, in such a way that, under favorable circumstances, *i. e.*, if the regenerated cause is brought in suitable contact with one or more other persons, the same disease will be induced in such person or persons;—in or on whose bodies, in their turn, the same regeneration of the cause of the disease will take place, by which the infectious process may be propagated, in the manner stated, *ad infinitum.*

This one quality necessarily involved in the definition of a contagious or infectious epidemic disease, is sufficient to characterize its cause as a *living organism;* for *the power of reproducing and propagating their own kind or species is an attribute belonging exclusively to living organic beings.*

The correctness of this deduction is corroborated by the following facts and considerations:

The causes of some infectious epidemic diseases are known, by direct observation, to be minute organisms, some of an animal and others of a vegetable kind. Thus the cause of the vulgar disease called the itch is a minute parasitical insect, which localizes itself on certain places on

the human body in the mucous layer, underneath the cuticle of the skin, and there reproduces and propagates itself, causing at the same time, by its irritating presence, on the terminations of the nerves of the skin, and on the nerves of the capillary bloodvessels, distributed there, direct and sympathetic influences, similar in some degree to the effects of long-continued tickling, and resulting in the disagreeable disease before mentioned, formerly the dread of mankind, but more recently gradually and nearly totally eradicated from the more civilized portion of mankind as a triumphant result of a more correct knowledge of its causation and nature.

Thus we also know, by direct observation, that the cause of the so-called "scald head," "honey comb" or "favus" disease of children, consists of a plantlet similar in its form and growth to the yeast plant.

There is, between the observed conditions and circumstances under which the development and propagation of the parasitical causes of putrefaction take place and those which evidently govern the causes of epidemic diseases, so much analogy, that both kinds of causes, in their essential characters, may be judged to be either identical, or at least homologous.

This identity or homologous nature will appear still more, if we consider the modus operandi of either kind of causes, by which they produce their respective effects.

The modus operandi of putrefaction and fermentation allows of no other explanation, but that the organo-chemical process of growth and development of the parasitical animalcules and plantlets, in the immediate presence of dead animal or vegetable substances, exerts on the latter a *catalytic* or contact influence that induces their chemical decomposition, which again results in the recombination of the separated elements, according to the predominant affinities then coming into play. We have an analogous process, induced exclusively by catalytic influence, in the decomposition of alcohol in the presence of a strong polaric

substance, such as sulphuric acid or platina, resulting in the formation of ether, carbonic acid and water, of the separated constituent elements of the alcohol.

The modus operandi by which the presence and development of minute animalcules or plantlets may induce disease in living bodies of higher organization, is twofold, viz.: 1st. By the catalytic influence which the organo-chemical processes of the development of the lower exert on the organo-chemical processes of the development of the higher organisms: and, 2d. By the mechanically irritating and disturbing influence of their presence, as foreign bodies, on the vital functions of the parts of the higher organisms with which the lower organizations come in direct contact.

This last-named influence may be compared, as has already been done above, in our allusion to the influence of the itch insect, to the influence of *tickling*. This universally known influence shows, in a strong light, what great and destructive effects comparatively minute causes may produce. Thus may the irritation caused by the presence of a fly, or other small insect, on the mucous membrane in the nose of an elephant, *if continued for a length of time*, throw the huge animal into convulsions and cause his death. One itch insect, if permitted to nestle underneath the cuticle of our hand, or any other part of the body, will cause so much itching in the skin of the whole body as to induce an irresistible desire to scratch.

Now, it is evident that neither influence exerted on the living bodies of higher organisms requires parasites qualitatively different from those exerting their influence on dead bodies. The catalytic influence in both is alike, and the mechanically irritating influence exerted on the vital functions of living organisms results from a vital state of the bodies acted upon, and may be exerted by either parasites.

Yet, our direct observation, as well as good logical deductions, shows that such parasites may be either of the

animal or vegetable kingdom, and that they may have other differences distinguishing them from one another. But all such differences apply alike to both, those acting on dead bodies and those acting on living bodies. Indeed, it will appear, in the course of the succeeding deductions, that parasites causing the putrefaction of dead bodies may, if introduced into suitable locations, in the living body, act as disease-creating parasites.

The difference of the influence exerted in either case may be deduced: 1st. From the different mode of development of animal and vegetable parasites: 2d. From the different degree of vital energy possessed by the parasites in their state of full development as well as in the various stages of their progressive development: 3d. From their generic differences in the parasites of either kingdom, which requires for each kind some peculiarity in the locality or field of their growth and development, whether on dead or living organisms.

Hence we may conclude, without fear of successful refutation, that *the parasites inducing epidemic diseases in living organisms of a higher order are identical with, or homologous to, the parasites known as the causes of putrefaction of dead animal and vegetable substances.*

This conclusion, proved by similar deductions, the author pronounced in March, 1846, in a discourse on this subject held by him, on invitation, before the German Medical Society of Paris. (Of the members present on that occasion, he remembers, among others, Dr. Carl Vogt, Dr. Strohmeier, Dr. Luschka, Dr. Pigné, Dr. Dieterich, Dr. Chelius, Jr., Dr. Walther, Jr., Dr. Wenk, the late Dr. Keller, of Philadelphia, etc., most of whom, and many of those not mentioned, enjoy more or less celebrity in the profession.) Some positions taken and maintained by the author, at that time, have been *vaguely* and *incorrectly* advanced by others, but no comprehensive and clearly defined representation of the whole subject has yet been produced, as far as he knows, by any other author.

II.—*These causes,* when surrounding, and in contact with, *living bodies of a higher order,* are KEPT AT BAY, and *prevented from developing on,* and *inducing diseases in, such bodies,* ONLY,—as a rule,—BY THE SUPERIOR POLARIC INFLUENCE OF THE VITAL FORCES AND PROCESSES IN OPERATION IN SUCH BODIES, which *permits no organic processes of minor organisms to be developed in their presence.*

III.—The *vital forces* and *processes* of living organisms of a higher order *may,* in their protecting polaric influence against the development of parasitical organisms of a lower order, BE OVERCOME, by the developing forces of seemingly weaker parasites—*a,* if the *vital energies* of the higher organisms in these parts, which are exposed to the intrusion of the parasites, are *essentially weakened;* or *b,* if the parasites should be *first* developed *to a high degree of vigor, before being brought in immediate contact with a surface of a higher order of organization,* suitable for its development; for instance, if the parasites or their germs, are brought on surfaces, where they may find *all conditions of their development in abundance* without coming, at first, in direct contact with the vital membranes, before they are *developed to an overpowering and injurious degree,* as appears to be the case in the development of the parasites which cause the *cholera.* It is evident, that these parasites induce the cholera, *after being introduced,* WITH THE FOOD, *into the small intestines,* and *there developed and propagated, in the chyle*—their most suitable pabulum—to *such a number* and *such degree of vigor,* as to overcome the vital polarity of the membrane, and *over-irritate,* by their very presence, as foreign bodies, and by the organo-chemical processes of their development and propagation, the *capillary blood-vessels* of the mucous coat, which results in *inflammation,* and finally in *complete paralysis* and *distention* of the capillaries, followed by *excessive effusion of blood liquor,* (the cause of the rice-water evacuations,) *thickening of the blood* remaining in the system, *sinking of the vital forces,* (collapse,) *sympathic irritations of the nervous centres,* inducing *violent cramps,* etc.

Diffusion.

IV.—The *germs* or *seeds* of the parasites are generally so *minute*, that they, as yet, escape direct observation; but many of the *developed* parasites are observable through the microscope, and some to the bare eye. The *germs* and *seeds*, and some developed bodies *of parasites, may be borne from place to place*, ON THE VAPORS OF WARM AIR. In such case they are termed "*miasma*," which means "a pollution,"—namely of the air; and *air filled with such miasmata*, is termed "*malaria*," which means "vicious air."—*Some* germs and seeds, and *most developed* bodies of parasites, are *too heavy to be diffused by the air;* they can, therefore, *be communicated*, from the places of their origin, or from one body to another; only *through direct contact* or *indirectly by being carried on articles of clothing*, etc. Such parasites are, therefore, termed "*contagion*," or, in the plural, "*contagia*," which means, "infectious substances, communicated only by (direct or indirect) contact."

All miasmata may, of course, also be communicated by contact, and thus become contagia. Some miasmata do, indeed, require an *additional conveyance* by solid or liquid substances, before they reach the place of their development, to produce diseases. Thus may the miasmatic parasites which cause the *cholera* be carried *on the vapors of warm air*, to the *vicinity* of their human victims; but, to *reach the chyliferous surfaces of the small intestines, they have to be carried thither* WITH THE FOOD, *on which they may have been deposited.* Thus, also, are the same cholera parasites, after being reproduced in great numbers in the intestinal tube of their victim, *first carried into the open air*, WITH THE EXCREMENTS OF CHOLERA PATIENTS, thence to be *immediately diffused*, CHIEFLY ON THE VAPORS ARISING FROM SUCH EXCREMENTS, spreading the infection as far as such vapors may be carried, *especially as far as the infectious seeds in such vapors may be deposited on articles of food, or on*

the mucous coat of the mouth of human beings, to be carried down WITH THE FOOD *into the intestinal tube.*

(The doctrine of PETTENKOFER, advanced in his report on the causes of Cholera, in 1854, consequently eight years after the date of the discourse above alluded to, is correct in the fact that the evacuations of cholera patients are instrumental in spreading the cholera infection; but *incorrect* in the theory, that such infection consists of *gases*, which are supposed to be generated from such ingredients of the excrements as may be absorbed by a certain porous soil, and that such newly-generated gases are added to the atmosphere, to be inhaled and carried into the blood of human beings; and, wandering with the blood, to the blood-vessels of the bowels, are there exhaled, to create the cholera, and, at the same time, to regenerate such ingredients as, added to the excrements, will again pass through the same cycle of formations as before. The absurdity of that doctrine is proved by the single remark, that Pettenkofer ascribes to *gases*, which *cannot have an organic formation*, the *exclusively organic* attribute of *reproducing* and *propagating themselves!*)

LOCALIZATION.

V.—The *precise localities* of the animal body on which parasites may be developed and propagated are determined—*a*. By the presence of *all* general conditions of organic development; and *b*. By the *peculiar adaptedness* of any locality for the growth and development of a *specific* organism.

The OPEN MUCOUS SURFACES, including those of the intestinal tubes, present, as a general rule, the only localities on which, *primarily*, the settlement and development of parasites may take place. In the progress of their development and propagation, however, they may be *extended over other portions of the body, particularly through the malpighian*

mucous surface underneath the cuticle of the skin, including the indentations enclosing the roots of the fine hairs (lanugines) and other follicles of the skin. But even in these mucous surfaces, each parasite locating there may thrive the most in some particular portions. Thus will the seeds of the parasite, which by its growth and development produces the *measles*, localize itself, *at first* on the *mucous coat of the mouth, throat* and *larynx*, also of the *nostrils*, and on the *conjunctiva* of the eye. Thence it will spread, in its further growth and development, over the greater portion of the Malpighian rete mucosum, selecting, particularly for its more vigorous growth, the indentations around the various follicles of the skin, with the exception of those in which the fine hairs have their roots.

The parasite which causes the *small-pox* will also, *at first*, localize itself in the *mouth* and *throat*, and *thence spread through the malpighian mucous net over the whole body*, thriving particularly and luxuriantly in the *indentations around the fine hair bulbs*, causing, by its presence and constant irritation of the fine capillaries, a high degree of inflammation, followed by effusion of lymph, the elevation of the cuticle around the fine hairs, by the accumulated lymph, the centre of the elevation being held down by the adhesion of the cuticle to the fine hair,—the transformation of the lymph into pus, the desiccation of the pustule by evaporation, the formation of the crust,—and, withal, the full development of the parasite and its production of seed, which will adhere to the under surface of the pustular crust. Fine particles of this seed, diffused through the air by the desquamation of the cuticle, and particularly by the breaking loose of the crusts, may be brought unto the mucous coats of other persons, especially of the mouth, or, by inoculation, into the rete mucosum of the skin, and there grow anew, and bring on the same processes, as regards disease and the reproduction of seeds, as previously.

The *scarlet fever* parasite also settles, *at first*, in the *mouth*

and *throat*, spreads through the mucous net of the whole skin, and grows most vigorously through the surface underneath the cuticle, without entering particularly into the follicular indentations. Hence it produces, by its irritating presence, *a general equable inflammation* over the whole surface of the skin, involving, by sympathetic influences, sometimes important internal organs. The excessive effusion of blood liquor through the walls of the semi-paralyzed, and consequently relaxed and distended capillaries, together with the parasitic formation and its seeds, will loosen the cuticle, which, therefore, will come off in scaly shreds, to the under surface of which the seeds of the parasite are attached. Fine particles of these shreds, with the parasitic seeds, or the latter alone, may be carried by articles of clothing, etc., to which they are attached, or by vapors of warm air, which will bear them over the *vicinity*, and *thus spread the disease by being deposited on the mucous coats of the mouth of other persons*, where the parasites find all conditions of organic development, unless the vital processes of these mucous coats are energetic enough to prevent, by the strength of their polaric influence, the development of these minor organic processes.

The parasitical growth causing *diphtheria*, generally confines its development to the mucous surfaces of the *fauces* and *larynx*. It appears to be originally derived from the *developed mold of dried or preserved meats*, kept in *damp* places and eaten *uncooked*. It may also be originally generated on fresh meats which, after being cooked, are *kept for days in warm damp places, to be eaten without being again cooked.*

These parasites appear to be too heavy to be carried on the vapors of air, unless, like the parasites of the *whooping cough*, they be *forcibly thrown* by vigorous coughing, from the mouth and larynx of the patient, into the near mouth of an attendant or visitor.

VI.—The *seeds* of such parasitic molds, although gene-

rally floating around us on the vapors of warm air, appear to be too weak in their vitality to be developed in the presence of higher vital forces; but, *being first developed on organic substances deprived of life and yielding, therefore, no vital resistance*, they may *become* strong enough in their vital energy to live on our vital mucous membranes, and there propagate.

In a similar manner may the *developed* germs of the *common* parasites, which induce putrefaction of *lifeless* animal substances, attain a sufficient degree of vital energy to live and propagate *in the mucous coat of the small intestines of living* higher organisms, *if carried thither with articles of food containing them*, such as *tainted* meats, etc., when *eaten uncooked*, or *tainted after being cooked*. Such *fully developed* and, therefore, *comparatively strong* infusorial parasites, if living and propagating on the mucous coat of the small intestines, must, *by their mechanically irritating presence* and *by the catalytic influence of their organo-chemical or vital processes*, produce deleterious effects on the *delicate glands* distributed through the mucous membrane of the small intestines, particularly of the *ileum*, which glands serve for the absorption of the chyle in its course to the chyliferous ducts. These irritations may result in the production of extensive *inflammation* and *ulceration of the mucous coat and of the said glands*, and thus not only induce *many local and general sympathetic symptoms*, but also, particularly, a *greater or less suspension of the supply of nutritive materials for the blood;* whence such disturbances, and their destructive effects, must soon result in *general starvation*, which, with all the concomitant symptoms alluded to, is designated by the term of "*typhus*," or "*typhoid fever*."

VII.—Although the *primary* effects of the development of organic parasites, on the animal body, will show themselves *in the localities where the parasites are first developed, and over which their development and propagation subsequently extends*, yet it may and does frequently happen, that the *sympa-*

thetic effects produced in *different*, and sometimes *remote*, parts of the body, are *far more serious* than the primary local effects.

Thus may the continued mechanical and catalytic, or dynamical irritations of the surface of the mouth and throat, and of the surface of the skin over the whole body, caused by the presence and development of the organic parasites, inducing the *small-pox* and *scarlet fever*, although, in their destructive effects on the localities concerned, exceedingly unpleasant and even loathsome, *cause much more serious and even dangerous* or *fatal effects, by the sympathetic irritation of important internal membranes, nervous centres,* or *other organs*, resulting in internal inflammations, dropsical effusions, dangerous congestions, cramps and convulsions, ulcerations, abscesses, tuberculous deposits, etc.

VIII.—It may so happen that, in existing epidemic diseases, where the *precise localities*, as well as the nature and *modus operandi* of the infection, are alike *unknown, we may be enabled to discover the same*,—at least sufficiently, for practical purposes,—*by exact physiological and pathological deductions, from their remote sympathetic effects.*

Thus we may judge, from the uniformly discovered existence of *pleuro-pneumonia*, in the so-named *Cattle Disease*, or "*Rinderpest*," that the *adequate cause* therefor *must exist*, and *act, upon a locality of the affected animal, to which such cause has access from without, and on which the exercise of a continued irritation may, by sympathy, induce internal effects, identical with the general fatal disease named.* It is, of course, always understood, that, inasmuch as the cattle disease is known to be infectious, which means that its cause is capable of its own reproduction and propagation—which is an attribute belonging exclusively to living organic bodies—this disease is caused by the influence on the body of the affected animal of the development and propagation of *organic parasites.*

Correct pathology, based on exact physiology, will show

that *most pulmonary diseases*, the one under consideration included, *result from sympathetic influences, derived from irritations of the skin, on the corresponding or forepart of the cnimal body.* (Even a common catarrh of the bronchial tubes or similar affections of the trachea and larynx are *not* caused by *direct* influences of the atmosphere on the mucous coat of the parts affected, but can be shown *to result by sympathy from the influences of changes of temperature on the skin of the upper part of the breast, the neck and head.*)

Thus we have two characters of the *cause* of the cattle disease, viz.: its nature as an organic parasite, and its localization on the skin of the forepart of the body, which, with the addition of the third character, already understood, and presently to be named, *will give us sufficient practical knowledge of that cause*, not only to enable us to destroy it, as the cause of disease in a given case, but also to destroy its seeds and to take measures to prevent its propagation and diffusion. The third character alluded to has reference to the precise locality, by which this parasite *can only reach the body of its victim, for its first development and propagation.* These are the mucous coats of the mouth, nostrils and perhaps of the eyes, because these surfaces and the air passages are the only localities on which parasitical organisms of so minute a nature can find the ready conditions required for their first development. The air passages are out of the question, because as a rule they rarely permit foreign bodies to develop on their surfaces, (evidently in consequence of their generally *powerful vital polarity, and the action of their ciliated epithelium,*) and because in this case if the parasite had developed itself there, catarrhalic symptoms would be the first and leading result, which is not the case.

Hence we may judge, that *the parasite of the cattle disease at first settles on the mucous coat of the mouth and nostrils*, and perhaps the eyes, and in its development and propagation *extends itself along the continuation of the said mucous*

coats, over the skin of the forepart of the body, i. e., *in the mucous net or layer underneath the cuticle,* causing, by its presence as a foreign body, and by the constant organo-chemical processes of its growth, an *irritating effect* on the *fine sympathetic* as well as *cerebro-spinal nerves distributed there,* which *effect grows in intensity or momentum, like the effects of continued tickling,* until it involves near and distant parts and organs, by nervous reflex action or sympathy, particularly the organs in the interior of the same region of the body, causing over-irritation of the primarily or secondarily affected parts, with all the more or less grave consequences resulting therefrom, even to the destruction of the life of the victims.

Prevention and Cure.

IX.—In order to arrive at some rational conclusion as to the best methods of preventing the inroads on our body of the various causes of epidemic diseases, we shall be most able to accomplish such object, by reviewing, in as concise and practical a manner as possible, the essential conditions of the existence and development of such causes By removing or suspending the action of any one of those conditions, we prevent or arrest the development of epidemic diseases.

The essential conditions of the existence and development of the causes of epidemic diseases, we have shown to be identical with the essential conditions, under which alone the causes of putrefaction can exist and be developed into activity. They are, as we have seen, the essential conditions of the existence and development of all living organisms, viz. 1, the presence of parental organisms or their seeds; 2, the presence of nutritive or albuminous substance; 3, the presence of water; 4, the access of air or free oxygen; 5, a sufficient degree of heat; 6, the absence of overpowering disturbing influences.

We will now consider each condition separately:

1. The parental organisms or the seeds of epidemic parasites may, like the parasites of putrefaction, surround us, or exist in our vicinity, at all times and in all places; as, for instance, the parasites causing measles, scarlet-fever, small-pox, diphtheria, whooping cough, typhoid fever, dysentery, etc.; or they may originally be found only in distant regions of the earth, and be brought near us only by being carried on suitable vehicles, say in the bodies of travelling patients, or in their baggage, or on merchandise, or in vessels, or on the vapors of warm air.

The original localities in which the cholera parasites appear to be indigenous, have been traced to the warm, low and marshy regions of Hindostan, where the growth of vegetable and animal organizations, especially of a lower order, is so prolific and rampant, that the higher organisms, although essentially favored by abundant means for their subsistence, are still constantly endangered for their existence, by innumerable powerfully developed fungous and infusorial parasites, against whose localization, development, and propagation on the human body, the vital polarity of the latter does not offer a sufficiently energetic protection.

The interior chyliferous surfaces of the alimentary tube of man offer to those parasites equally favorable and luxuriant fields for their development and propagation; wherefore, when once colonized there, they may be carried in the manner above described, by reproduction and propagation, through the carriage of human excrements and their miasmatic vapors, and finally through the food on which the miasmata are deposited, to the intestines of untold numbers of human beings, as far as social and commercial intercourse may extend.

So much appears to be certain, both from "a priori" judgment and from uniform experience, that *the reproduction and propagation of the cholera parasites outside of their original homesteads in Hindostan, and of perhaps some*

similar tropical swampy regions elsewhere, does not find a more suitable locality, than in the alimentary tube of man.

If, therefore, all persons living near the original source of the parasites, could be sufficiently instructed, and prevailed upon, never to eat any food that is not thoroughly cooked,* and to *wash their mouth* before each meal, by any disinfectant liquid, such as a solution of one grain of corrosive sublimate in one ounce of water, or of ten to twenty drops of sulphuric acid in half a pint of water, or *to drink, one or two hours after every meal, a glass tumblerful of common lime water, with ice,* or, in place of that, *once in every twenty-four hours,* say before retiring to bed at night, *a large tumblerful or more of cold spring or ice water, slightly acidulated by two or three drops of sulphuric acid, and sweetened to taste,* —and for children a proportionately smaller quantity:— they would never suffer from cholera; because, by such means, the parasites would be destroyed, either before entering the alimentary tube, or after having entered, before they could come to any development. Many similar preventives will suggest themselves, which perhaps may be more suitable than those mentioned.

If, then, in this manner, the people near the original source of the infection could protect themselves, it follows of course, that *a similar course will protect us during the prevalence of the epidemic, wherever we are.*

It is equally evident, that the best *protection against the diffusion of the infection,* from the excrements of cholera patients, is the *instant efficient disinfection of all excrements from the bowels of such patients,* among whom all such persons must be included who suffer from the slightest symptoms of derangement of the bowels, during the prevalence

* This precaution as to the eating of pork, is now generally practiced in Germany, to prevent infection by "trichina," the cause of the swine plague. Dr. W. H. Ford, of this city, who is on a scientific tour in Germany, writes that microscopical investigations have shown, that the infectious trichina (a minute worm) is developed within six days for reproduction, and then lays innumerable eggs.

of an epidemic, or who have been anywhere where they might have swallowed the infection.

It is not enough that the vessels used by patients should be *speedily emptied,* and the water closet frequently purified by chlorinated lime, in the usual manner; but *the vessels used by the patients should contain fresh chlorinated lime while they are used,* in order to let the excrements, as they are evacuated, *immediately* come in contact with the disinfecting gas of the chlorinated lime, and thus *cause the vapors of the excrements to be disinfected as quickly as they are formed.*

If this precaution is strictly carried out, both by private attention in families, and by public advice, and superintendence, no case of cholera can happen in any community, beyond the case or cases imported.

In cases where the infection has actually taken place, or where light symptoms of derangement of the bowels, such as nausea, disagreeable feelings in or near the middle part of the abdomen, a light diarrhœa, a fainty sensation, etc., render it probable, that infection has taken place, then a tumblerful of ice water with a tablespoonful of brandy or whisky, containing two or three drops of sulphuric acid and $\frac{1}{12}$ grain of morphia, should be taken immediately, children to take a proportionately smaller dose. In the course of half an hour or sooner, if the symptoms should increase, another tumblerful of ice water, acidulated by sulphuric acid, and containing the same dose of brandy or whisky, and of sulphate of morphia, as before, may be drunk.

Such drinks may be taken every half, one, two, or three hours, until the patient feels well, or until from six to twelve drinks have been taken. If ice water should not be at hand, cold spring water may answer the purpose.

The *cold* water and the *sulphuric acid,* tend each *to destroy the parasites* wherever they meet them, while, at the same time, in such quantities and under the circumstances named, *they act very beneficially for the digestive tube.* The

morphia is recommended to be added, in order to cut short any irritation of the capillaries of the mucous coat, which might already have taken place, and thus *to prevent the dangerous sympathetic diffusion of such irritation.* The brandy or whisky is recommended as a specific and speedily acting *stimulus, to meet any exhausting influence* which might already have been at work, before further injury may be done.

The parasites causing the *yellow fever,* although also *of exclusively tropical origin,* appear somewhat capable to be reproduced, during the heat of summer, wherever the thermometer of Fahrenheit ranges above eighty-six degrees, in more northern latitudes, outside of the human alimentary tube, especially if *imported by patients,* and *deposited with their excrements,* in *warm, damp* and FILTHY *localities, presenting all the additional conditions of development of minute vermin.* Their chief diffusion however, in northern climes, is effected by *reproduction of the seeds in the bowels of patients,* and by their direct *dissemination through the vapors of the excrements,* which deposit them on articles of food, or in the mouth of new victims, thence to be carried, with the food, into the digestive tube.—Hence similar methods of disinfection will be advisable, as recommended in regard to the cholera.

One precaution, which physicians and visitors, who are not compelled to remain long near patients, or in their vicinity, should practice, is, *never to take any food in the sick room,* or in the house or vicinity of a patient, and when returning home from the visits of infected localities, to *wash their mouth* by lime water, or by water acidulated by sulphuric acid, and *then to drink a glass of ice water,* to which two or three drops of sulphuric acid may be added; also, if otherwise advisable, a tablespoonful of brandy or whisky. To disinfect articles of food coming from infected localities, they may be placed for half an hour in a closet, or other closed place in which some fresh chlorinated lime is placed in a saucer half filled with water.

The chlorine gas which is readily disengaged from chlorinated lime, is an efficient destroyer of minute organic formations, both animal and vegetable, while in such light diffusion admixed to the air, it exerts no deleterious influence on higher organisms. This gas being diffusible through the air, and, therefore, meeting the parasitical germs anywhere, as they are carried on moist vapors, or deposited on food, or other objects, it is the most suitable disinfectant, in the gaseous state, existing.

For the destruction of *fully developed parasites,* however, the chlorine gas does not appear to be sufficient,—at least in the proportions generally disengaged and applied. Such fully developed parasites are fortunately not easily carried on the vapors of the atmosphere, but reach new victims generally only by direct or indirect contact. They may be destroyed by liquid disinfectants, among which a moderately strong solution of corrosive sublimate of mercury holds the highest rank. This poison, in the strength of four grains to the ounce of water, *externally applied* to the animal body of the higher order, will not cause any injury worth naming, and yet *effectually destroy all animal* and *vegetable parasites,* with which it comes in contact.

Corrosive sublimate may therefore be named the most efficient disinfectant for the destruction of parasites which develop in the mucous coat of the mouth, throat and nostrils, and in the mulpighian mucous net underneath the cuticle over the whole skin of the body. If ten or twelve grains of corrosive sublimate are dissolved in as many ounces of *hot* water, and the mouth and throat and nostrils washed with the same, by means of a small sponge, and, thereupon, the whole surface of the face (except the interior of the eyes), the head, the neck, the breast and arms, and the whole body downwards, in such a manner that the cuticle is sufficiently *soaked,* with the hot solution, to cause the latter to *penetrate into the mucous net beneath the cuticle,* and *there to reach the organic parasites,* which may be developing there: there is every reason to expect that such a treatment,

if applied in the incipient stage of scarlet fever, measles, and *small-pox,* will *arrest the further development of the infectious parasites,* and consequently not only *cut short the diseases named,* but *destroy also their power of infecting other persons.*

The same treatment applied in the *incipient* stage of *diphtheria* may suffice to *immediately check the progress of that disease.* The sublimate solution may, in such cases, be used as a gargle, and a few times repeated, of course *with care* not to swallow any considerable amount of it.

It is equally probable, that one grain of corrosive sublimate, dissolved in a quart of water, and then drunk at one time, so as to be speedily carried down through the whole digestive tube, thus to reach all infectious parasites which may be there, in the progress of development, will effectually *destroy them,* and thus *prevent the development of typhoid fever,* or *infectious dysentery,* if applied in the developing stage of those diseases.

The sublimate being in such cases, so far diluted as to lose its corroding influence, it may, no doubt, be once or twice repeated, at intervals of at least one day, if such repetition should be considered requisite, to insure greater immunity.

This principle of action being once rationally and scientifically established, the time may be near, when the full truth of my prediction, enunciated twenty years ago in my discourse above alluded to, will be verified, that *corrosive sublimate will be recognized as the universal destroyer of the parasitic causes of all infectious and epidemic diseases, and that, by its and kindred means, we shall be enabled to liberate mankind from the ravages of those subtile, but fell destroyers.*

From the deduction of the *organic nature* and *precise localization* of the cause of the *cattle disease,* above given, it is now equally probable that *corrosive sublimate* will be found to be an *efficient destroyer of that cause,* and that, by its free and judicious application, *that plague of our most valuable animals will be abated.*

For this purpose, a solution of twenty or thirty grains

of sublimate in an equal number of ounces of *hot* water, may be applied, as an efficient *wash for* the *mouth, throat,* and *nostrils,* and for the *whole skin of the front part of the body* of the infected animal, which washing may, for greater security, be once or twice repeated.

It may also be applied in all cases where infection is *suspected;* and, *to prevent* infection, the mouth, throat and nostrils of animals *subject* to infection during the prevalence of the disease, should be washed once every two or three days.

The sublimate is not only an efficient destroyer of parasites, but it serves also as a valuable remedy against the sore throat, and against the pleuritic and pulmonary inflammation and ulceration, especially if *several times* applied as a wash, in the manner indicated.

2. The *second* general condition, viz., the presence of nutritive or albuminous substance, required for the development of infectious parasites, may be efficaciously removed, to prevent the growth and propagation of such parasites, *by the cleansing out of all filthy places near human habitations, especially as far as they contain animal and vegetable offals, or dead bodies.* This subject is, however, sufficiently agitated in all civilized communities to need no further comment. It is enough that the *rationale* of such cleansing processes has been indicated.

3. The *third* general condition, or requisite, viz., the presence of a neutral diluent, or water, for the development of infectious parasites, or their seeds, explains why, as a general rule, no infection takes place on any part of the animal body, but on the *open* mucous membranes, including those of the digestive tubes, to which the parasites, or their seeds, may find access. Although the whole skin of the animal body presents albuminous substance on its surface, and although the parasites, or their seeds, may be freely deposited there, yet, as a rule, no development of the parasites, or their germs, can take place, because the dry and insoluble cuticle, although albuminous, cannot serve

as food for the parasite, for the want of a diluent, or water, required to induce the mutual organo-chemical process between the parasites and such nutriment. The exceptions to this rule may be threefold: 1. The parasite may be sufficiently powerful to creep over the skin, and *burrow through the fine scaly layers of the cuticle into the mucous net beneath*, and there find a nidus for its further development and propagation. This process I have repeatedly watched in the "*acarus scabiei*," a minute infectious insect, which causes the *itch*. 2. There may be sufficient accumulation of *moist filth* on the skin, especially on the head, to serve as a place of development for the seeds of minute vegetable fungi, such as the "favus" plantlet, which is very similar to the fermentation or "yeast plant." The cuticle underneath such moist filth may by it be sufficiently *moistened*, and rendered *permeable*, for the progressive development and extension of the developed fungous parasite, into the mucous net underneath the cuticle, and thus the localization of the "favus" fungus, which is a perennial plant, and causes the disease known as "*favus*," or "*scald-head*" of children, become permanently established. This course of development I have also repeatedly and accurately watched, and it is a familiar occurrence in the observations of Professor HEBRA, the distinguished dermato-pathologist of Vienna. 3. The cuticle may, in some locality, be *abrased*, either by accident or by design, and thus a road of entrance be opened for some parasite or its germs, to the mucous net underneath the cuticle. Thus may open sores on very decrepid animal or human bodies, become places of development for the common parasites of putrefaction, whose germs, floating on the vapors of warm, damp air, generally surround us. Thus I have also seen the before-mentioned favus plantlet designedly transferred from the head to the skin on the arm, by the crust formed on the head being lifted, and a minute particle of its under-surface being detached and inserted underneath the cuticle of the arm by

the point of a penknife. The plantlet grew and spread, in the course of three weeks, to an extent of over half an inch in diameter, causing inflammation in the affected locality of the skin, and the formation of a crust similar to those on the head; which crust being finally removed, and the place washed well, by a solution of corrosive sublimate, no further formation took place, and the injured spot soon healed. In the same manner the disease on the head was removed.

A common and striking exemplification of this mode of localizing parasitical germs, in the mucous net underneath the cuticle, by artificial insertion, is the process of *vaccination*. As it is intended to treat on the subject of vaccination more at large, in a succeeding paragraph, we content ourselves with having mentioned it in the preceding connection, to which may also be added the former practice of the inoculation of the small-pox virus.

Usual absence of moisture in the atmosphere accounts also for the peculiar healthiness and immunity from infectious and epidemic diseases enjoyed by some favored localities on our planet. Such localities are also more or less free from the processes of putrefaction and decay of animal and vegetable substances. And, on the other hand, do we find that the putrefaction and decay of animal and vegetable substances, and the progress of infectious diseases, are particularly favored by warm, damp air, in low locations, along river courses, etc.

4. The fourth general condition of the existence and development of infection, viz., the presence of air, or free oxygen, may be successfully removed, and an infectious progress arrested, in cases of parasites growing over the surface of our skin. These parasites may be destroyed by effectually *greasing the whole body* with sweet oil or other grease, and *thus depriving them of the access of oxygen.*

It is probable that the "*unctious*" treatment of patients suffering from the itch owes its success as much to the deprivation of free oxygen (air), to which the insects in

the skin are subjected, by being covered with grease, as to the poisonous character of the medicinal ingredients of the ointments used. Scarlatina has also been reported as having been arrested in its progress by keeping the patients for days enveloped in a coat of grease.

The face of small-pox patients has been kept free from the development of the disease by covering it, in the incipient stage, with a coat of collodium.

5. The fifth condition of organic development, the requisite degree of temperature, may be removed in various ways. Scarlet fever has been reported as checked by the infusion of large quantities of very cold water over the whole body of patients. Also, small-pox and measles have been thus treated, in their first development, with success. Numerous reports on the yellow fever agree in the observation that this epidemic ceases to diffuse itself whenever the temperature of the atmosphere falls below eighty-six degrees. The cholera, originating in the warm climate of southern Asia, diffuses itself by the open air,—*i. e.*, on a comparatively large scale,—*only* during the warm summer months; and wherever it is found during colder seasons, it can be traced to its origin in warmer regions and its transportation in the bodies of persons infected, who travel, *during its incubation*, to colder regions, and there spread it by their excrements, within warm, enclosed places, to the attendants or visitors of said localities. This explanation will sufficiently account for every instance of the appearance of the cholera in mid-winter, or in cold northern climates. A similar explanation will also account for the otherwise paradox phenomenon that the small-pox is apt to be more diffused during the winter season than at other times. Careful investigation will show that such diffusion is depending entirely on infection from the immediate room or the enclosed and heated atmosphere around the patients. The same observation is applicable to the diffusion of measles and scarlet fever during winter. While thus every indication points to the

requirements of a certain degree of heat or warmth, which is not far below, nor far above, the blood heat of living beings, for the development of infectious diseases, we have equally clear and unmistakable evidence that extremes of low or high temperature, as compared with animal heat, viz., cold near or below the freezing point, and heat at or above the boiling point of water, effectually prevent all infection, which proves the homology, or identity,—as to their nature of being living organisms,—between the causes of infection and of putrefaction, as above stated.

6. The sixth condition of development of organized beings is a negative one, viz.: the absence of overpowering disturbing influences. This condition, considered in its many bearings, will be found to be the chief protector of the human family against the numberless destructive influences which constantly surround us.

By the experiments of Schwann and others, showing the nature of the causes of putrefaction of animal and vegetable substances, it has been made evident that those causes, as living animal and vegetable parasites, constantly surround us. As the only power which prevents those parasites from inducing the decomposition or putrefaction of our own bodies, we have no other protecting agent to look to, but our own vital force, or polarity, resulting from our constant process of organo-chemical transformation; because the moment that this vital force, or polarity, is lost in any animal body, we see speedily the development of animal or vegetable parasites, or both, on such body. Even if only a part of an animal body has lost its vitality, we soon see the same process of development of parasites on such part.

Hence it follows that the greater the energy of our vital force, especially in parts subject to the inroads of parasites, the more securely are we protected against their localization and development on us; and, conversely, the less vigorous our vital forces may be, particularly in the parts

on which parasites may be deposited, the more likely shall we be encroached upon by them.

As far, therefore, as we may be enabled to increase the energy of our vital force, or polarity, in the parts subject to the localization of parasites, we shall be able to strengthen our security against them. This accounts for the various degrees of immunity from infection enjoyed by many persons.

X.—It indicates particularly the causality of our *immunity* from *special* infection, *acquired*, or *artificially created*, by passing through a process of development of such infection, or of a *similar* infection. Thus we find, with rare exceptions, that persons who have once passed through the small-pox disease, through the scarlet fever, through the measles, and some similar contagious diseases, are never afterwards again affected by the same disease.

We find also, that persons who have artificially induced the small-pox on their bodies, by inoculating themselves with the infectious matter taken from the pustule or crust of patients, acquire an equal immunity from future infection of the same disease. And, what appears still more remarkable, we find that the artificial inoculation of human beings with the infectious matter of the cow-pox, (viz., vaccination,) if followed by the development of a pustule and a comparatively light local inflammatory and general febrile disease, establishes an immunity, enduring for life, in such persons from the infection of the small-pox. Occasional exceptions from this immunity can be accounted for on the same principle, namely: that by some greater influence, affecting the vital polarity of the person vaccinated, the special strength or polarity acquired by having passed through the vaccine disease, and preventing the development of the small-pox infection, may have been lost.

As an explanation of the *modus operandi* by which such immunities may be effected, or, in other words, by which a sufficient increase in the vital strength or polarity in the parts exposed to infection, to prevent the development of

the infectious matter, is produced, the following may be offered:

The growth and development of every part of our body is promoted by the judicious exercise of its functions. By exercise we can develop our muscular system to a degree of strength which would be incredible, if it were not occasionally exhibited by gymnasts. By exercise we can strengthen our brain to a degree of mental performances far above the common mental activity of the world. The power of endurance of the injurious influences of the weather may, by careful and judicious systematic exposure to the same or similar influences, be so much increased as to render it perfectly safe, and even agreeable, in situations in which other persons, not accustomed to such exposures, may be very injuriously affected, and even perish.

Thus we can easily imagine that the mucous membrane of the mouth and throat, and the mucous net underneath the cuticle of the skin, may undergo a rather severe, although still bearable, exercise from the steady irritation caused, for a number of days, by the presence and development of foreign bodies, consisting of infectious seeds and developing and developed parasitical organisms, probably of a fungous nature. This steady exercise, principally of the mucous membranes implicated, if successfully passed through, must, of necessity, produce a greatly increased strength or vital polarity in those membranes, which increase of vital force may be great enough to establish the vital polarity of such membranes as an overpowering disturbing influence against the development of parasitical seeds or organisms, tending, if permitted to be developed, to excite the irritation of the same membranes in the same direction.

And, as we have seen above, in the deduction of the probable cause of the rinderpest, that the irritation in one part of the body may induce sympathetic irritation in corresponding other parts, thus will also the exercise and its results in one part produce sympathetic exercise and

similar results in corresponding distant parts. Observing, therefore, that the local inflammation caused by vaccination is attended, sympathetically, by general excitement in the system, evidenced by fever and other symptoms, we may easily conclude that the known sympathetic relation between all mucous membranes will, in a measure, cause the exercise of one portion of them to be an exercise of all. Hence the immunity of all mucous membranes, induced by the inoculation of infection, and by the resulting general sympathy with the local disease.

And still further, as in the theory of exercise it can be shown that a comparatively gentle exercise, steadily pursued, may have more effect in strengthening the exercised parts than more violent practices, so it looks reasonable that the comparatively mild exercise of the mucous membranes, induced by the less virulent infection of the cow-pox (vaccination) may have at least as much effect in strengthening those membranes to make them proof against the inroads of the small-pox parasites, as the inoculation or infection of these parasites themselves.

This leads us to the suggestion of experiments for the discovery of enduring preventives of a similar nature against the scarlet fever. As the cow-pox is, according to all appearance, the modified small-pox of man, and as the thus modified parasite, if applied on man, induces the much milder vaccine disease, which is, nevertheless, a sovereign protector against the small-pox, so it is probable that the rinderpest is a modified scarlet fever of man, and that the virus of the rinderpest—say the viscid saliva from the mouth of the infected animal—if inoculated in the arm of a child, like cow-pox matter, will induce a modified and lighter disease, the effect of which may be an immunity for life from the infection of the real scarlet fever. One child thus inoculated may reproduce infectious matter enough to propagate it over the world.

In all such inoculating operations we should be very careful never to introduce the infectious matter deeper than

the mucous layer underneath the cuticle. If we cut deeper, and perhaps open the side of a vein, or of an absorbent vessel, we run the risk of introducing into the venous or lymphatic circulation, not only cells of the parasite, but also pus cells, of which the crust, or carrying vehicle, contains large numbers. Pus cells are at least six times as large as blood corpuscles, and, if added to the blood, they make pyaemic blood, the least effect of which will be that the pus cells passing through the pulmonary artery into the lungs, will there obstruct the small arteries, not to say the capillaries, which they are too large to enter. Such obstructions in the circulation lead to the formation of tubercles. If pus cells are brought into the lymph vessels, they produce glandular swellings along their course, which may result in all the phenomena of the so-called scrofula.

If persons who have been inoculated or vaccinated, or who have had the regular small-pox, or scarlet fever, or measles, or similar infectious skin disease, pass afterwards through a very depleting and reducing process of disease, such as typhoid fever, etc., they may lose, with the lost vital strength, the immunity from such diseases. Re-vaccination in such cases is evidently very proper.

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