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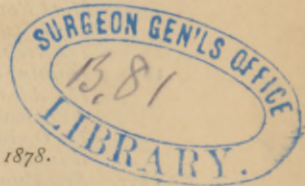
THE GERM THEORY OF DISEASE,  
AND  
ITS PRESENT BEARING UPON PUBLIC AND PERSONAL HYGIENE.

READ BEFORE THE ABOVE ASSOCIATION, OCTOBER 17TH, 1878.

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THE FOLLOWING IS A LIST OF THE PAPERS READ BEFORE THE  
ASSOCIATION.

- 4 1871. *Compulsory Education.* By Lorin Blodget. Out of print.  
*Arbitration as a Remedy for Strikes.* By Eckley B. Coxé.  
*The Revised Statutes of Pennsylvania.* By R. C. McMurtrie. Out of print.  
4 *Local Taxation.* By Thomas Cochran.  
*Infant Mortality.* By Dr. J. S. Parry.  
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cundity, Longevity and Mortality.* By John Stockton-Hough, M.D.  
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THE GERM THEORY OF DISEASE, AND ITS PRESENT  
BEARING UPON PUBLIC AND PERSONAL  
HYGIENE.\*

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THE devastating epidemic of yellow fever, now raging in some of our Southern States, has called forth so much discussion in regard to the nature of this and kindred maladies, that few persons of culture have failed to hear, more or less, in the last six months, of the Germ Theory of Disease.

This hypothesis, of which, for more than ten years, I have been an earnest advocate, notwithstanding its unpopularity, both within and outside of the medical profession, has, in consequence of some recent discoveries, begun to be received into favor by many physicians, although many more still look upon it with distrust, if not with contempt.

Hence, without endeavoring to convert you all to a faith in the absolute truth of its tenets, I believe the time has now come for me to point out exactly what its doctrines are, to enumerate the chief facts which form their support, and to indicate the precautions which, if we admit it is probably true, wisdom enjoins upon us towards preventing the propagation and spread of disease.

In order to render myself clearly understood, I will begin by explaining, in the first place, that the Germ Theory of Disease, which was propounded by the celebrated Linnæus more than a century ago, but has since been somewhat modified by its successive advocates, professes to account for the phenomena of small-pox, typhoid fever, yellow fever, relapsing fever, measles, scarlatina, diphtheria, chicken-pox, erysipelas, etc., by attributing them to the more or less mechanical irritation and other disturbances set up by masses of spores and mycelial threads developing in the blood and in the affected tissues. The period of incubation (by which is meant the time between exposure to small-pox, for example, and the development of the complaint), is supposed to correspond with that required for the germination of these spores. The gradual increment of the symptoms is attributed to the progressive growth of the millions of minute fungoid plants whose period of greatest

luxuriance marks the acme of the attack, and the death and destruction of which correspond to the decline of the disease. The contagiousness of the communicable maladies is accounted for, as you see, very beautifully by the existence of the immense number of spores (the true seeds of disease) constantly produced, evolved from the affected individual, and carried through the air of a room or house, either alone or attached to some of the innumerable epithelial cells, which are constantly being rubbed off by millions from the surface of our bodies. The general absence of second attacks is admirably explained by the hypothesis that the parasitic fungus, on the first occasion, has exhausted all, or nearly all, of some peculiar (unknown) organic ingredient in our bodies, which is absolutely requisite for its support, according to the very same law that will cause, as every farmer knows, his wheat to fail if he plants it repeatedly in the same ground and neglects to secure a due rotation of crops.

At the outset of my plea in favor of this doctrine, let me say that, in spite of the bold assertions of certain enthusiasts and savants, with whom zeal outruns knowledge, no really skilful microscopist will at present maintain that minute vegetable organisms, found in connection with contagious maladies, are as yet proved to have any definite relation to them as causes of disease.

Nevertheless, the presumption that such causal relation does exist, is, in my opinion, so strong that I intend to ask you to accept my judgment that it will be demonstrated in the near future, and I therefore seek, in this address, to popularize the conception that contagious diseases are conveyed from one person to another by the transplanting of microscopically visible spores, or seeds, which have a separate vitality of their own, each after its kind, and which are to be escaped, just as we would escape hordes of animal, or swarms of insect pests, by shutting them out or killing them before they can succeed in fastening upon our bodies.

I urge upon you, gentlemen, and upon the community at large, such a practical recognition of this theory now, because I believe that before many years it will be, with perhaps slight modifications, fully and amply demonstrated from microscopical and clinical research, and all true philanthropists must, it seems to me, desire that humanity should benefit by this knowledge, even at the present hour, although the conservative opponents of the Germ



Theory, whilst evidently wavering in their defense, are not yet driven into the last ditch on this side of complete surrender.

I believe, as I wrote some years since, in regard to Favus, a parasitic skin disease of children, (*Hand-book of Medical Microscopy*, Philadelphia, 1871, p. 252,) "We see to-day the same old battle fought (now in regard to small-pox, diphtheria and their congeners), which, fifty years ago, was so strenuously contested by Biett and Morgagni, on the one hand, and the microscopists on the other, in relation to scabies, or the itch, at present universally admitted to be due to a minute insect, the *Acarus Scabiei*; and to the student of human nature it is a most interesting confirmation of the wise king's dictum, "There is no new thing under the sun," to observe how the same doubts, followed by the same objections, were urged against the parasitic character of the itch that are now put forward in opposition to the vegetable nature of the cause of ring-worm or favus. Thus, Biett, Cazenave, Lugol, etc., denied then, that, even with the aid of microscopes of high power, any insect whatever could be discovered. When, by a succession of lucky accidents, so many observers blundered into seeing the insect, that this position was no longer tenable, opponents to the parasitic theory changed their base of operations, and admitting the occasional existence of the *acarus*, stoutly maintained that, instead of being the cause of scabies, it was a secretory product of that affection, and by no means a constant one. Finally, when *proof* that the whole disease could arise from the deposit of a single itch insect upon the skin of a previously healthy person, became incontestable, the anti-microscopists took refuge in the assertion that in such cases "the insect, taken from the scabious vesicle, *being charged with the virus, the fluid of the vesicle*, by penetration of the cuticle inserted this virus and produced the disease," as the inoculation of cow-pox is accomplished.

One of the strongest arguments against the doctrine that living germs can enter human organisms from the alimentary canal, is that derived from the *a priori* probability that the solvent action of the gastric and intestinal juices must destroy all vitality in the microscopic organisms which on this hypothesis constituted the morbid matter, the *contagium vivum* of disease. A fundamental step towards establishing the Germ Theory, therefore, was manifestly that of proving that Bacteria, or analagous low forms of life,

could penetrate from the stomach to the blood, to be thereby carried into all parts of the system, and this, I was, I believe, the first to demonstrate. My observations were detailed in the *American Journal of the Medical Sciences* for July, 1868, from which I extract the following as the most important :

Experiment 4th. At 7.45 P. M., May 17th, 1868, I drank four fluid ounces of water, similar to that employed in the preceding investigations and containing multitudes of Bacteria, estimated as numbering 27,000,000,000. At a quarter past eight, I examined a drop of blood drawn with the aid of a cataract needle from the tip of my finger and confined between a slide and cover cleaned with strong hydrochloric acid. Under the field of the one-twenty-fifth inch objective, the interspaces between the rows of blood corpuscles were found to contain multitudes of apparently spherical molecules, in rapid and erratic motion, but so very minute as to readily escape notice even with this high power, except under the closest scrutiny; in the course of half an hour, not less than one hundred were observed. At 9 P. M., another drop of blood, examined with the same precautions, exhibited, in addition to these minute particles, other bodies less active in their movements, of much greater magnitude, and which under an amplification of 1,100 diameters, appeared precisely similar to the Bacteria I had been studying a few hours before in the identical decomposing beef juice imbibed. Five of them were thus enlarged so as to exhibit an unmistakable organized structure, totally different from their associated aggregations of Beale's germinal matter. Three of these Bacteria were each about one-twelve-thousandth of an inch in length and one-twenty-five-thousandth of an inch in width, very distinctly constricted in the middle; a fourth was obviously composed of four, and a fifth of six joints, arranged in a straight line, the motion of which, was of that peculiar waving character so universal among the Oscillatoriacæ. The last two were most clearly visible when they happened to lie vertically to the surface of the glass, and would probably escape observation under the one-eighth inch, except in that position, or be therefore mistaken for simple globular bodies, although in several cases I detected in the second and third experiments (with a lower power) a shadowy elongation of one diameter of the revolving molecules thus observed.

These results of mine were corroborated soon after by the re-



searches of Dr. Neffel of New York, upon some of the inferior animals, in regard to which, he informs us (N. Y. *Medical Record*, July 15th, 1868, p. 226;) "My experiments so far lead me to the conclusion that the lower vegetable organisms can continue to live and multiply in the tissues of living animals, and that they can enter into the general circulation, either through the intestinal canal or respiratory organs, or by means of hypodermic injections. What is their ultimate fate in the animal organism, and what their importance in producing disease further investigation will have to show."

M. E. Semmer, in *Virchow's Archives*, April, 1870, in his paper on the "Results of Injection of Fungous Spores and Fungous Cells into the Blood of Animals," gives additional corroboration of the conclusion to which I arrived by personal experiments.

Notwithstanding these and other investigations, the Germ Theory of Disease made but little real progress, at least in English speaking countries, until about three years since, when the researches of Professor Burdon Sanderson and E. Klein of London, as set forth in Mr. Simon's Report for 1874, as Medical Officer of the British Privy Council, commanded much professional attention and doubtless led many who had previously ignored the theory to examine anew its claims to credibility.

In this report are endorsed the next two great steps towards the establishment of the Germ Theory, namely, the experiments of Oertel and Nassiloff, who showed that if the cornea of a rabbit is lightly pricked with a needle that has been thrust through diphtheritic false membrane, the wound does not heal up as similar tiny punctures with clean needles do, but becomes in a few days the centre of radiating streaks of brownish opacity, which under the microscope are seen to be made up of colonies of the vegetable spores (micrococci) of diphtheritic disease. The other important step was the detection by Obermeier of Berlin, of a minute fungoid growth (spirillum) in the blood of patients suffering with Relapsing Fever, a fact which Professor Stricker of Vienna, whose world-wide fame as a most skilful microscopist renders his testimony conclusive, told me only a few weeks ago he had fully confirmed.

These and other researches, led Dr. William Roberts of Manchester, England, in his Annual Address before the British Medical Association last year, to assert that the Germ Theory of Disease

"is now established upon a firm experimental basis, and if fairly grasped in capable hands, will very soon give us most important aid in our struggle with disease;" and a recent eminent German writer on Pathology, Professor Orth, late of Berlin, now of Göttingen, declares "of all the modifications which the blood undergoes, the least understood and at the same time the most important, is unquestionably, that which is due to the admixture with low organisms. Recent researches leave no doubt whatever, that in some diseases the blood contains during life, though to a far higher degree after death, certain low forms of animal or vegetable life. Those organisms which have a thoroughly characteristic appearance can be detected without any great difficulty, with very high powers, provided the layer of blood which is examined be very thin, or that the red corpuscles have been destroyed with acetic acid or alkalis." \*

The latest, and perhaps most important, advance toward actual proof of the Germ Theory, has just been made by my friend, Professor E. Klein, F. R. S., of London, who, in a series of admirable investigations, partly communicated to the Royal Society in February 1878, shows that a kind of bacterium found in the peritoneal exudation of pigs affected with a disease sometimes called typhoid fever (but more properly entitled *Pneumo-enteritis contagiosa*), may be cultivated in indifferent fluids outside the animal's body for *eight successive generations*, and then produce the original malady in healthy animals upon which it is inoculated.

The daily success of Lister's Antiseptic Method of Dressing Wounds, now firmly established in the London and many of the Continental hospitals, is a further and almost unanswerable evidence of the infective power of germs, and the wonderfully lucid explanations and ingenious experiments of Professor Tyndall have done much to enable all to realize the intimate relation which exists between Dust (which consists largely of germs), and Disease.

It may not be amiss, before leaving this part of my subject, to

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\* Dr. Orth describes the grey coating on wounds affected with Hospital Gangrene, and lining the uterus in puerperal fever, as being made up chiefly of micrococci and bacteria. He also asserts, what I long ago believed and taught, that in metastatic abscesses, and probably in carbuncles and boils, the starting point of the slough which forms the core, is found in a small artery plugged up by a little wandering mass of micrococci or fungous spores.



reply to an objection which has been frequently offered to observations upon Bacteria, met with in connection with various diseases, namely, that such organisms, apparently quite identical, are often detected in absolutely healthy animals, and therefore cannot be causes of disease. Those who urge this argument, however, seem to forget that since the Bacterial spores and rods are only the analogues of the seeds and roots of larger plants, and by no means entire organisms, it is, therefore, no more reasonable to expect us to distinguish the bacterium which develops into the cause of Yellow Fever, for instance, from that which produces simple putrefaction, than it is to demand we should discriminate at sight, the root and seed of a choke pear, from those of a seckle. In either case it may be only by cultivating the plant to its full perfection, and testing its ripe fruit, that we can determine its place in nature.

Abandoning, as I said before, all claim at present to certainty that the Germ Theory of Disease is true, let us consider in conclusion, what modifications of the ordinary sanitary precautions we can wisely adopt in view of the *probability* that Bacteria, or closely allied organisms are the actual causes of constitutional diseases.

In the first place, it seems to me that great benefit would result from its being understood by every man, woman and child, that the contagion of small-pox, scarlet fever, typhoid fever, yellow fever, measles, diphtheria, cholera, etc., is probably composed of exceedingly minute spores, or seeds, so small, that 20,000 of them placed end to end, would measure less than one inch in length, and a mass the diameter of one of the periods (.) upon this printed page might contain 50,000,000. Each one of these 50,000,000 of seeds is capable, under favorable circumstances, of reproducing its kind with almost inconceivable rapidity; so that, supposing, for example, the *Zygodesmus* of Professor Letzerich is really the morbid agent causing diphtheria, a particle of of the greyish false membrane of the size of the dot just mentioned, would contain separate seeds enough to infect every inhabitant of the whole continent of North America with diphtheritic disease. But, whilst this is the theoretical possibility, practically, the same law of prodigality of nature exemplified in the spawn of the herring and salmon holds good, and not more than one spore in a thousand, a million, or a hundred million, perhaps, has an opportunity to reproduce its species.

As there is no doubt that the contagion of the diseases just

enumerated may penetrate into our systems by the air we breathe, the food we eat, and especially the water we drink, it is obvious that only the most scrupulous care can save us from these extremely minute seeds, or insure their destruction after entrance into our bodies is accomplished. If these germs were singly disseminated, it would be almost impossible to avert constant infection, but as they generally are carried about by winds or currents in aggregations of thousands or tens of thousands, of course the chance of imprisoning them, or otherwise shielding ourselves from them, is largely increased. It seems probable that the epithelial cells continually shed from our integument and constantly floating about in the atmosphere in great numbers, and which, as shown in some observations of my own, upon the white incrustation upon brick house fronts, are met with in the dust deposited upon the highest points of four-story buildings in crowded thoroughfares, are often vehicles for small groups of these spores which adhere to them.

The obvious deductions from these facts, tend to strengthen the urgent recommendations of sanitarians, that every effort should be made first, to prevent these morbid germs from being let loose upon the world, and second, when they have made their escape into the free air or water, to destroy all spores likely to come in contact with unprotected persons, that is to say, human beings from whose bodies one crop of small-pox (or cow pox) fungus, yellow fever bacteria, relapsing fever spirilla, etc., has not already been raised.

Each individual affected with small-pox, scarlet fever, diphtheria, or any other of the diseases above mentioned, is, according to this theory, to be looked upon as a sort of *hot bed* or forcing house for the seeds or spores of that malady. From his or her body are continually given off in all directions, by the skin, the breath, the perspiration and other secretions, millions of spores of the extreme minuteness I have described to you, each one of which, if it were received into a human system, under favorable circumstances, would rapidly reproduce itself, and after a few days or weeks (corresponding, as already mentioned, to what is known as the period of incubation) give rise to a new case of the disease, again a new hot-bed of contagion for other unprotected organisms.

Now these spores, just like the seeds of larger noxious weeds, which, when allowed to gain a foot-hold in our fields and gardens, propagate themselves with such immense rapidity, have no power



to move of their own accord, and can only develop if they meet with air, moisture and congenial soil suited to their peculiar requirements. That is, if a small-pox patient is shut up in a germ-tight room so that the seeds cannot escape, or, if whilst in the open air that air is stagnant, so that no seeds are wafted away from the immediate neighborhood of the individual, or, if when carried along by the wind, they are blown away from any human habitations, are desiccated in a dry atmosphere, baked by the sun's rays or artificial heat, frozen by extreme cold (as seems to be the case with yellow fever germs), or finally, if they happen to meet with no persons but those who have had small-pox or been sufficiently vaccinated, in other words, if they do not "fall upon *good ground*," all this wealth of provision by which nature tries so hard to secure the perpetuation of the poisonous plant, causing small-pox in our systems, becomes unavailing and her malevolent design against our race, carried out with such a prodigality of murderous weapons, utterly fails.

This brings me to the notice of one of the most common and most mischievous popular errors which a general acceptance of the Germ Theory will necessarily subvert, namely, the belief that small-pox and other contagious maladies often arise without previous exposure to the seeds of the disease. This doctrine, frequently advanced in private life as an excuse for neglect of proper care and caution in regard to children, etc., and occasionally sustained by public authorities as an apology for violation of quarantine and other sanitary regulations, is exceedingly pernicious, and our warmest gratitude would be due to the Germ Theory of disease, even should its establishment render no other service to humanity than the explosion of this fallacy. The fact is, as I firmly believe, that (inverting the Scriptural aphorism), we can no more gather thorns from grapes, or thistles from figs, than we can have, for instance, the germs of yellow fever growing from clean cotton, or those of cholera developing from uninfected rice.

Putting aside the primary origin of diseases, which, with one or two doubtful exceptions, is a question of prehistoric time, the Germ Theory of Disease teaches us that every new case of the contagious maladies already enumerated, is the immediate off-spring of a preceding case, and the direct result of exposure of an unprotected human being to the chance of having the spores or seeds of disease

implanted in its system, an exposure which it only required sufficient knowledge, sufficient foresight and sufficient care to avoid.

This pernicious belief, as I deem it, in the spontaneous endemic origin of the contagious diseases rests, at any rate, on entirely negative evidence, namely, the circumstance that cases do sometimes spring up in which it is impossible to trace the affection back to a personal source of specific propagation, and yet, such an event is only what we have reason to expect from the very nature of these diseases, since the active principle of the poison is invisible to the naked eye. Hence, in the ordinary affairs of life, unless special precautions are resorted to, ways are open for the spread of these microscopic agents of propagation in a thousand unseen modes, so that, obviously, the precise source of infection and its track must often remain undiscovered by the best wisdom of man. I have seldom been more forcibly impressed with this truth than when, upon one occasion a few years ago, a stalwart man entered, in his turn, my prescribing-room in the Pennsylvania Hospital, and on his lifting his hat I saw his forehead was covered with well-filled pustules of small-pox, at about the sixth day of their development. In reply to my reproof for thus exposing other patients in the waiting room of the Hospital to this terrible disease, he assured me (mendaciously, I presume), that he did not know what was the matter with him, and that, being a stranger in the city, without home or friends, he had, when taken sick, come to the Hospital, since "he must have some place to go to." I hastened him off to the office of the Board of Health, whence he was doubtless forwarded to the Municipal Hospital; but the point of interest in this connection is, that if, as is probably often the case, there had happened to be in that waiting-room an unvaccinated child upon whom the infection from these pustules was propagated, no one connected with the infant could have suspected the source of contagion, as my small-pox patient had his hands concealed in gloves and wore a full, heavy beard, which, with a hat pulled low down over his eyes, effectually shielded his loathsome disorder from observation.

Of course, this is not an isolated case, but only an example of what we all, young and old alike, are constantly exposed to in the streets, the cars, and all public places in a large city. I cannot but hope, however, that as soon as our legislators become convinced that the Germ Theory is true, we will have what our English



cousins enjoy the advantage of, *i. e.*, stringent laws to prevent such culpable injury to innocent persons. Meanwhile, our only safeguard is to protect those under our care by the precautions of early vaccination and the most watchful seclusion from possible exposure to the sphere of influence of such contaminating individuals, who constitute, as I consider, hot-beds for generating the tangible seeds of disease.\*

In all such instances, indeed, isolation from unprotected persons, carried out with every due consideration and kindness, is, therefore, to be practiced, if possible, and under other conditions, means which will destroy the life of the spores, such as dry heat of high degree, super-heated steam, prolonged boiling in water, caustic acids or alkalies, are to be used, with a firm confidence that if they are employed thoroughly enough they will absolutely put a stop to all spread of the disease.

A very important suggestion in regard to the use of disinfectants, arising from our knowledge of the Germ Theory, is, that since these spores doubtless float in the atmosphere, as do the seeds of the thistle or dandelion, and are no more susceptible to the action of chemicals, with which the air containing them is impregnated, it is useless to expect any certain and complete results from the milder aerial disinfectants, as usually employed, that is, by scenting the medium in which they are suspended with carbolic acid, camphor, acetic acid, and similar non-corrosive agents.

As to the lesson we may deduce from these teachings in regard to Public Hygiene, I think its importance is only surpassed by its simplicity.

For such contagious and infectious maladies it is: *Avoid, at any cost, the entrance into communities of living spores or seeds of disease.* And this should be insured, not as in former times, with the mere *hope* that somehow we might escape the visitation, but with the absolute certainty that with proper care infection cannot occur.

No doubt many of us have smiled at the story of certain terror-

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\* Some years ago a medical friend of mine attended, in a large town not a hundred miles from New York, two successive cases of small-pox in the house of a dealer in ready-made clothing. The whole stock of coats, pantaloons, etc., numbering many hundreds had an opportunity of being impregnated with the seeds of the complaint, and should have been disinfected with scrupulous care. They were, however, sold at retail, just as usual, and may have given rise to scores of cases of "idiopathic" (?) small-pox.

stricken authorities in a German town, who, when a single potato-bug was discovered in a field near them, immediately covered the whole plantation with straw soaked in kerosene, and, setting fire to it, destroyed every vestige of animal and vegetable life for acres around. And yet, if we consider a moment, we realize the fact that this apparent waste of time, trouble, and potato vines, was the wisest and most economical expenditure that could possibly have been made.

How much more, then, when our own lives and the lives of those that are dear to us, in addition to scores of millions of dollars are at stake, as they are now in the South, should sanitary authorities be armed with almost despotic power, in order that they may shut out, or kill every one of these actually visible and even tangible seeds of disease. Quarantine, disinfection and prolonged detention of persons, with disinfection, or frequently total destruction of goods from infected districts, is, it appears to me, the *right* of the many at the expense of the few; and even if, as I should advocate, for the sake of strict justice, ample compensation for loss of time and loss of property were allowed by law to those who suffered, I believe the community at large would be tenfold better off pecuniarily, to say nothing of the far more important saving of human life and human suffering, which would be secured.





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