THE GERM THEORY OF DISEASE.

ITS PRESENT STATUS AND PRACTICAL APPLICATIONS.

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Ladies and gentlemen :

Along with the annual farewell extended to the graduating class, by the Trustees and Faculty of this Institution, it has been their custom, for many years, to present for the consideration of the audience, a study of some topic of current medical thought, of mutual interest to the public and the profession.

Of all the range of subjects which may properly be considered as meeting this requirement at the present time, none perhaps exceeds in interest and practical importance the so-called "germ theory" of disease. To a brief and non-technical review of some of its leading features, therefore, I shall invite your attention this evening.

DEFINITION OF GERM THEORY.

Dismissing, with a bare reference, the large class of diseases long known to be parasitic in origin, such as the trichina disease and the itch, amongst those due to animal parasites; and various skin diseases due to vegetable growths—the germ theory of disease, as at present discussed, may be defined to be—that doctrine which ascribes the production of certain diseases, called infectious and contagious, to the introduction and multiplication within the body of certain minute vegetable organisms called "bacteria."

The question, then, "What are disease-germs?" resolves itself into the question,

"WHAT ARE BACTERIA?"

We may condense the volumes that have been written up on this question into the statement, that bacteria are vegetable organisms, each consisting of a single cell (or elementary particle) microscopic in size, usually colorless, and capable of rapid and enormous increase in numbers under favorable circumstances, by means of reproduction by fission (simply breaking in two) or by means of spores produced in their interior.

Botanically speaking, they have been classed with the *fungi*, by reason of their rapidity and mode of reproduction, and because of their lack of the vegetable coloring matter called chlorophyll. In these particulars they perhaps resemble mushrooms more than any other vegetable growths with which we are ordinarily familiar, yet, so simple is their structure, or rather lack of it, that they are perhaps farther removed from the mushroom in the scale of vegetable life than the oyster is from man in the animal scale. So much, then, for their comparative simplicity in a structural sense.

Some idea of their size may be conveyed by the statement that, ordinarily it requires the use of a magnifying power of several hundred diameters to even *see* them, and even then many species appear as mere specks in the microscopic field. Notwithstanding the fact, however, that bacteria are the smallest of living things, they are, in every sense of the word, *adult* organisms, hence the word "germs" applied to them is a misnomer, as implying an embryonic condition. Being of a strictly *vegetable* nature, the popular term animalculæ is likewise radically incorrect.

FORMS OF BACTERIA.

Physically, under a magnifying power of from 500 to 2000 diameters, they may be seen to be of *three chief forms*, namely—*globular, cylindrical, and spiral*—a globular bacterium is called a *micrococcus*; a cylindrical one, a *bacillus*; a spiral one, a *spirillum*.

THEIR DISTRIBUTION.

As regards their distribution, they are found wherever organic matter exists in process of decay; and decay begins where life ends if bacteria be not excluded. Hence, we may obtain specimens from the water in which a boquet of flowers or other vegetable matter has lain for a few hours at ordinary temperatures; the surface of your tongue will furnish several species that have been received with the air or food, and made their home in the cast-off mucous and particles of food found in the mouth; a single speck of dust, barely visible to the eye, may be composed of hundreds of bacteria; even distilled water contains them after short exposure to atmospheric dust; all dead bodies, vegetable and animal swarm with them; they exist in the soil upon which we walk, the air we breathe, the water we drink and the food we eat: in short, wherever, on the surface of the earth the temperature is not constantly below the freezing or above the boiling point, living bacteria may be found. Their spores will survive under conditions that will kill every other living being.

USES OF BACTERIA IN THE ECONOMY OF NATURE.

While then, as we have seen, bacteria, as a class, are the smallest, the most widely distributed and the most difficult to destroy of all living things, they may be said to be at the same time, a most important factor in the *preservation of life.* To elucidate this latter statement we may quote from Magnin, a distinguished French mycologist, who says, "It is known, that organic matter, once produced and become solid, so to speak, cannot again enter into the general current (of life), until it has undergone new transformations, produced, according to some *savants*, favored, according to others, but, without contradiction, accompanied by, the development of bacteria." In other words, bacteria, by reason of their action in putrefactive processes are the "*reducing agents*" to use a chemical phase, in Nature's laboratory, analyzing or decomposing dead organic matter into its inorganic molecules or atoms; and were this action to cease universally, dead organisms would continue to accumulate on the surface of the earth until all existing organizable matter would be "locked up," so to speak,—*latent*, to use a chemical simile,—in the dead animals and plants of ages. Hence, to use the language of Magnin again,—"it is thanks to them (bacteria) that the continuation of life is possible on the surface of the globe."

While this is evidently only another way of stating that *every link is essential to the integrity of the chain of Nature,*—yet it calls our attention forcibly to the fact, that bacteria are not by any means an unmitigated nuisance to the human family. Again, their importance to us in the chemical processes of every-day life can hardly be over-estimated, since they are the essential agents in the conversion of alcohol into vinegar, and in several other fermentative processes. Even the yeast fungus, which raises our bread and converts sugar into alcohol, while not a bacterium in a botanical sense, is yet of very similar structure and general characteristics.

Bacteria then, may be said to be objects of extreme interest to the naturalist and the man of general culture, as well as, in a restricted sense, to the physician, the pathologist, the sanitarian, and the chemist.

ECONOMIC CLASSIFICATION OF BACTERIA.

A distinguished botanist (Sir Joseph Hooker I believe) has said, "A weed is a plant of which we do not know the uses." Applying this principle of classification to the bacteria, we may divide them, from an economic standpoint, into three classes, namely:

1. Beneficial, including those of putrefaction and fermentation already referred to.

2. Negative, or those whose action is unknown—the *weeds*, so to speak, of bacterial life,—and constituting, at present, by far the largest class.

3. Injurious, also called pathogenic or disease-producing bacteria.

To this latter class then, let us devote a few moments attention.

So far, we have confined ourselves within the limits of actual, undisputed facts in the natural history of an important class of plants.

We now enter the domain of dispute,—where fact and fancy, speculation and logic, assertion and denial, crude deduction and scientific experimentation, are intermingled on all sides, in the most chaotic confusion; while so recently has the entire scene been swept by an intellectual cyclone, that the lightning of criticism and the thunder of argument, have not yet ceased to play, over the wrecks of hypotheses and the remains of dogmatic opinion.

Picking our way cautiously then, over this dangerous ground, what may we find, that has weathered the storm, in condition to be of service to us from a practical standpoint.

MODES OF ISOLATING PATHOGENIC BACTERIA.

So far as physical appearances are concerned, the bacteria of disease differ in no marked manner from those of putrefaction, fermentation, etc., occurring as they do in all of the three chief forms of globules, cylinders and spirals; so that, for purposes of study, they can only be separated by what are technically termed, culture and inoculation experiments, conducted by experts skilled in the use of the microscope and familiar with the clinical phenomena and post-mortem appearances, caused by disease. These experiments, of course, are mainly performed on the lower animals, although students of medicine have been found sufficiently self-sacrificing and enthusiastic to permit of experimentation on human beings.

RESULTS OF EXPERIMENTS.

Without entering into the details of this interesting subject, it is sufficient to state here, that, by means of these experiments various kinds of bacteria *are* isolated, cultivated, inoculated and *proven to cause, each a particular disease and no other.*

DISEASES CAUSED BY BACTERIA.

What diseases are they?

Amongst the diseases thus proven, beyond a doubt, to depend upon the presence of special bacteria are: Anthrax or splenic fever, tuberculosis or consumption, relapsing fever and glanders.

These diseases, we may note in passing, are common to man and the lower animals, and hence afford favorable conditions for experimentation.

Others, whose bacterial origin is *extremely probable*, but still imperfectly established, are: Cholera, typhoid fever, smallpox, vaccine disease, measles, diphtheria, leprosy, septicæmia and some others.

DECISION BASED ON EVIDENCE.

Now, I would not have you suppose that the bacterial causation of disease is universally accepted. The volumes that have been written *pro* and *con* may be numbered, perhaps, by thousands; the importance of bacteria is ignored by a few, denied by some, accepted by others, exaggerated by many.

Suffice it to say here, that, decided as questions of fact are in courts of law, namely, upon the *weight* of the *evidence*, the *question* as to whether certain bacteria are the essential cause of certain definite diseases in man and other animals, must be decided in the *affirmative!* as having the support of by far the greater number of competent pathologists and mycologists who are recognized authorities!

HOW BACTERIA MAY CAUSE DISEASE.

The question as to *how* they act does not affect the decision. Briefly, they may occasion the phenomena of disease in three ways:

1st. By their enormous increase choking up the minute blood-vessels, thus interfering with the nutrition of tissues and the action of excretory organs.

2d. By altering the chemical constitution of the blood and other tissues—by fermentation, so to speak.

3d. By the production of poisonous chemical products.

In either mode may the life of the victim be endangered.

BACTERIA NOT THE ONLY CAUSE OF INFECTIOUS DISEASE.

The question now arises—if the bacteria of a given disease, tuberculosis, for instance, are almost universally present, *why* do some contract the disease whilst others escape. It is evident that *something more* than the mere presence of the bacteria is involved in the production of infectious disease.

What is this something? *We do not know!*—it is the X of the algebra problem, which yet remains unsolved!

Like many other things of which we know little or nothing, however, it has several names. We call it vitality, idiosyncrasy, etc.; *in effect* it is the *resisting power* of living organic matter to the *agents whose duty it is to reduce it partially or wholly to inorganic matter.*

TWO FACTORS INVOLVED.

We may consider then, as the *two factors* in the problem of infectious disease:

First. Diminished resisting power.

Second. The bacteria.

In other words, the *soil* and the *seed*; either being inoperative without the other. To put the problem another way: It is as manifest that pathogenic bacteria, coming in accidental contact with *healthy* tissues, will fail to multiply in sufficient numbers to cause *disease*, as that *corn* sprinkled upon a *bouldered street* will fail to produce a *corn crop.*

But, we hear it argued, "here is a man in *perfect health*, stricken down with cholera, or smallpox, or some other infectious disease"—how do we account for this?

Inquire into that man's history for a week, a month or perhaps for years—has he inherited a feeble organization? has he been underfed or overworked? is he dissipated in his habits? have business or domestic affairs weighed too heavily on his mind? does he sleep in a well-ventilated room?—in short, are his *tissues*, to use a commercial phrase, "*below par*" from any cause whatsoever?

The cases of infectious disease in which some preceding anti-hygienic influence cannot be traced are certainly rare if not unknown.

PRACTICAL APPLICATIONS OF BACTERIAL THEORY.

What, then, is the most practical lesson we may learn from our present knowledge of the causes of infectious disease?—simply this! *The preservation of the normal integrity of the tissues is equivalent to depriving the bacteria of a soil in which they can multiply to a dangerous extent!* How may this be effected? In a word, by hygiene.

Again, we may render the tissues obnoxious to at least one disease by communicating a milder one, that is—by vaccination; the future possibilities of the more extended application of this principle are great.

A large proportion of the community however, are almost necessarily, perhaps through no fault of their own, predisposed to various infectious diseases; can we do nothing to aid them in their struggle against the common enemy?

SOURCES OF INFECTION.

Here the *source* of infection assumes a practical aspect; and of all the routes by which the cause of infectious disease reaches any community, none, perhaps, are more important and less regarded than the water-supply.

How often do we hear gravely discussed the supposed dangers of sewer-*gas*, which has never yet been proven to cause a single disease—while at the same time we lay pipes to convey to our houses the sewage itself—not only of a large portion of this city, but of some 200 or more towns on the Ohio above. True, it is diluted more or less with Ohio River water, but the dilution grows uncomfortably small during low water, and the prevalence of various diseases increases in an inverse ratio.

How does the sewage cause disease?—it *conveys the bacteria contained in the refuse from thousands of sick-rooms!* Do the inhabitants of unsewered districts possess any marked advantage in this respect? No!, since their sources of water supply are always liable to contamination by surface drainage; and too frequently are the well, the cistern, and the cesspool in intimate relation; it is a notorious fact, also, that certain diseases of the class we are considering are relatively more prevalent in unsewered suburbs and small country towns than in the larger cities.

The water-supply then, may be regarded as one frequent source of infection.

A second source is the milk; this may be a source of infection by reason of the water with which it is adulterated—or in which the vessels containing it are washed.

Secondly, it may be a product of tuberculous cows—tuberculosis, as is well known, being a disease common in cattle.

As we cannot well watch all sources of infection by fluids, what may we do to protect ourselves against them?

ANTISEPTICS.

Barrels of ink, and tons of printed matter have been expended on the subject of antiseptics or bacteria-destroyers; and the merits of carbolic acid, permanganate of potassium, bi-chloride of mercury, etc., are discussed at great length by a multitude of writers.

Much of this literature and the experiments on which it is based, are extremely interesting from a scientific standpoint, but neither is so practically important to the general public, as the knowledge, that *hot water*,—plain, simple, old fashioned *boiling water*,—is, without exception, the *most effective*, *most harmless*, and *cheapest* of all the antiseptics we possess. On this fact all mycologists are agreed.

The house-keeper, who applies this principle yearly in preserving fruit, and so kills the bacteria of putrefaction, has only then, to thoroughly boil all water and milk used for domestic purposes, in order to destroy the pathogenic bacteria it may contain.

The most effective weapons then, with which we may resist the onset of infectious disease are:—

First. Hygiene, which renders unproductive the *soil.*

Second. Heat, which destroys the *seed.*

DUTIES OF THE PHYSICIAN.

A word, then, in conclusion, as to the professional aspects of the subject.

The idea that infectious disease will ever cease to exist is, of course, Utopian. It is a well-known fact however, that these diseases are, in themselves, self-limited,—that is to say, the bacteria cease to multiply after a time and favorable cases recover spontaneously within a definite period!

It does not follow however, that the services of the physician are superfluous. On the contrary, it is in his power to see that the patient is properly fed and nursed; to mitigate painful or annoying symptoms; to foresee and perhaps avert complications, often more serious than the original disease; and finally, by the *intelligent application* of his knowledge of the natural history of bacteria, to prevent or limit the *spread* of the *contagium*!

VALEDICTORY.

Gentlemen of the graduating class! The Trustees and Faculty of the Miami Medical College have honored me with the pleasant, yet painful duty of bidding you farewell!

You now enter upon another stage of your medical pilgrimage.

You bear away with you the evidences of your years of study and application, in the dissecting room, the laboratory, the lecture hall, and the hospital. The best wishes of your teachers, who have shared these labors, and of a multitude of friends, go with you as you resume your journey toward the Mecca of your desires.

Gentlemen, I wish each and all of you that measure of success in your chosen profession, which your acquirements and past record abundantly promise!

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