are due to very slight force, like spontaneous fractures anywhere; and while they may be ascribed to brutality or carelessness on the part of attendants, I am inclined to think this is often not the case; and that they are in that condition that they will break almost spontaneously on account of the feeble state of the system. This occurs occasionally among those in perfect mental health. I have once or twice seen myself fracture of the rib caused by coughing in an otherwise reasonably healthy individual; in a person somewhat obese and of about sixty years of age. In this case, after a violent attack of bronchitis and repeated coughing, the rib gave way after an expulsive effort. This should prove to us that in so thin and slight a bone as the rib it may become porous, and give way without any positive severe violence.

OSTEOMALACIA.

A very curious condition is osteomalacia, in which spontaneous fracture takes place over and over again. In these cases the patients frequently live to grow up, and the limbs are deformed with innumerable fractures. In such cases among children the slipping down off the chair on the floor will cause the leg to give way; and these breaks, fortunately for the individual, heal promptly, and then give way in another place the next time. This is a little different from the condition known as rickets or rachitis; because that is a condition of the bones in which they bend rather than break. In true rickets, the proportion of earthy salts and organic matter, as existing in the healthy bone, is reversed. The result is cartilaginous, weak, flexible bones, with rather enlarged joints. The spine bends; the breast bone bends; the head sinks between the shoulders; the legs curve out in all directions. Frequently the tibiae curve forward so that they are arched; and various other deformities occur.

In this condition, considerable can be accomplished by apparatus to keep the child's limbs straight; and by building up the child's strength with proper treatment, such as iron and cod liver oil, tonics, nutritious food and open air.

Bones break sometimes, apparently, spontaneously, but really as a result of tumors which are forming in them insidiously. This is especially true of cancer, or osteosarcoma of the femur, tibia or other bones. These occasionally give rise to what appears to be at first spontaneous fracture; and the force which breaks the bone is generally very slight—turning over in bed has broken a femur in the middle of the shaft in a case of unsuspected cancer, or osteosarcoma.

This form of malignant disease generally begins in the medullary cavity, grows and extends, rapidly absorbs and pushes out and thins the shaft or shell of the bone until it becomes so brittle that it gives way; and the cause is wholly, in these cases, malignant disease; so that in elderly people a case of spontaneous fracture, or fracture from insufficient cause, of the shaft of the bone should give rise to a great deal of suspicion as to what made it, and whether it is not probably due to commencing malignant disease of the bone itself. In the shaft, I say, because it is well known that old people break the neck of the thigh bone and neck of the humerus from absorption of the bone, without any form of malignant disease.

Various tumors grow in bones, some of an erectile nature, which pulsate and are mistaken for aneurisms. They form in the medulla, rapidly accumulate a mass

of enlarged vessels, throb and beat, absorb the bone just as an aneurism does, push out in a fungus pulsating mass, weaken the limb, and are recognized as a soft pulsating swelling about the femur or tibia, but are truly vascular tumors in the bone itself.

Myeloid disease also deceives us often in regard to the condition of the bone. It is true that myeloid disease rarely occurs in very young subjects; but its favorite site is the head of the tibia, and it forms very slowly; expands the head of the tibia; weakens the limb; gives rise to pain; generally to febrile symptoms; and is difficult to diagnosticate, at first, from caries occurring in the head of the tibia. Caries in the head of the tibia in young subjects is common; myeloid in the head of the tibia in adult subjects is not very uncommon. They frequently are mistaken one for the other. An incision, which seeks to relieve the caries and scoop it out, and falls upon myeloid disease, soon shows us what the mistake is; and in that case amputation is the only resort, and has to be done above the joint. The disease is incurable, malignant. Amputation should be done early to save the patient.

Now, it is necessary to know this sort of thing because it must give us great caution in operating, and in bearing in mind that we cannot tell exactly what we have got to expect when we operate on deep tissues; and that the alternatives must be ready in our mind; and that we must be prepared, and perhaps have prepared the patient, by saying, that we will endeavor to remove the disease; but that we must do what is necessary in order to save life; and if we find any incurable trouble, we may have to amputate.

Original Articles.

MEDICAL TEACHING IN GERMANY.¹

BY CHARLES F. WITHINGTON, M.D.,
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AMERICANS who are likely to consider the subject of medical study in Europe, fall into three classes:

First, the small number of those who, either having received their general education abroad, or having been impressed with the excellence of European medical teaching, decide to take their entire course of medical study and their degree at some European university. I cannot but look upon this as an error for those who intend to practise in our country, for such men find themselves on entering upon their professional career at home at a disadvantage in the following ways:—Their therapeutic armamentarium is rather different from that to which American patients are accustomed, and though they can, of course, readily enough learn the differences between the European and the United States pharmacopœias, yet they are likely to find that a good deal of the sort of medication which is swallowed with avidity or at least with resignation by the hospital patients of Berlin or Vienna, will meet with decided opposition from the self-respecting American stomach. Again, the man who has received his entire medical education abroad knows nothing of these professional traditions and usages to which patients here expect conformity, and which alone can make one's relations with his fellow practitioners endurable. Finally,

¹ Read at the meeting of the Suffolk District Medical Society, October 28, 1893.

a lack of personal acquaintance with any of one's professional neighbors or with any of the older or more prominent physicians of the city or State where one is to settle, must be counted as a great disadvantage.

The second and numerically the largest class of persons contemplating foreign medical study is composed of men who have taken their medical course and degree at home, but who wish further preparation for practice, and are considering whether they can best secure such practical experience as they desire, at home or abroad. Yet it must be freely admitted that if these young men can afford but one year in addition to their required curriculum, a resident house-officership in a good general hospital offers advantages superior to any they can find under other circumstances in any country.

Third, comes a class which I hope and believe is destined to become an increasing one, of men who having already become established in practice, feel a need of temporarily interrupting their work by further study with a view either to specialization, to consultation practice, or to such a picking up of lost threads, such a broadening of the professional horizon, as Harvard offers to her professors in the "Sabbatic year," but which we medical practitioners, while we need it quite as much as any other class of professional men, find it harder to get. If it is not possible to obtain it every seventh year, yet at a longer interval or for a shorter period, it is not, as I have reason to believe, impracticable. The practitioner who, with any of the motives I have just sketched, wishes to change temporarily his horizon, and to "go to school" again, will generally, if possible, cross the water to get what he wants, despite the excellent polyclinic and post-graduate advantages that our large cities now offer.

In a paper like the present, it is manifestly impossible to attempt to cover the whole field of foreign medical teaching, and I shall, therefore, in what I have to say to-night limit myself to a consideration of Germany, and especially Berlin.

Medical study in Germany differs from that in England and in our own country, in that it is always pursued at a university, where it shares in the broadening influence produced by the bringing together of various departments of learning about one common centre. There are about twenty of these universities, the largest being those of Berlin and Munich. As the capital of the chief German State, Berlin stands easily the intellectual centre of Germany and probably of the world. Her university, though less than a century old, comprises nearly seven thousand persons and numbers among its professors some of the brightest lights in the firmament of science and letters.

The German student of medicine passes to his professional studies either from the gymnasium, where he is supposed to have spent nine years in liberal studies, consisting chiefly of classics and mathematics; or he may come to medicine from the Réal School, where modern languages and science replace the classical training of the gymnasium. The gymnasium, however, is held by the best medical men, and by the government also, if we may judge from the distribution of official patronage, as the only adequate preparation for professional study, the Réal School being considered as an educational concession to the popular element. As the gymnasium takes boys at an average age of about nine, they are ready at eighteen or at nineteen (adding the year for compulsory military service) to begin their medical studies, unless they choose, as a few do, to

take some semesters with the philosophical faculty of the university before passing on to the medical. Unless they do this, their basis of general culture is less than that of our best medical students, for the gymnasium cannot be held as at all equal to our best American colleges. On the other hand the Germans gain two or three years in time over our college and medical students.

The required medical course occupies eight semesters, (four years). At the end of the second year comes the first examination, the *tentamen physicum*, which covers chemistry, organic and inorganic, mineralogy, physics, botany, anatomy, physiology, zoology, embryology and histology. Near the end of the course occurs the examination on the other usual subjects of medicine, for the doctorate, or medical degree, in case the student chooses to apply for it. But as it is in many cases held to be a useless luxury, being rather expensive and quite unnecessary for medical practice, the student often reserves his money and energy for the State examination, which is essential to engaging in medical practice, which is a severe examination, conducted by government officials, and which makes of every successful candidate in a certain sense an officer of the government and invests him with corresponding authority and responsibility.²

I do not believe that the average German medical student is as well equipped as the average graduate of our best schools, that is, those having a four years' course. For, in the first place, the time of actual study is not so long. The winter semester nominally lasts from October 15th to March 15th, and the summer semester from the middle of April till the middle of August. Here are apparently nine months of term time. But no pretence is made of beginning work before November 1st or of continuing it after March 1st. In fact, the "vacation courses" begin March 1st, two weeks before the close of the regular term for which the students have paid. The same amputations are applied at both ends of the summer semester, and when to these lengthened vacations we come to add a two weeks' holiday at Christmas, and the first, second and third days' celebration of the various religious and secular festivals, there is probably not left more than seven months net out of the twelve for work.

Again, our academic "hour" for teaching purposes is fifty-five minutes. In Germany, the first fifteen minutes are always thrown off and the remaining forty-five minutes are, according to my observation, often considerably further reduced. So that the German lecture or clinic averages from twenty to twenty-five per cent. shorter than our own.

As to the instruction, it is generally admirable. The examination is thorough, the diagnosis shrewd, the literature discussed voluminous, recent and widely drawn. But despite, or perhaps because of the excellence of the elucidation, the average student gets probably less advantage from it all than he would from trying to unravel a few obscure cases for himself. To be sure, he serves his time as *praktikant*, when he makes more or less for a "snap" diagnosis. But he rarely works up a case in careful detail. His point of

² I have heard it said by some Americans that they found the diploma examinations in Germany remarkably easy. It may be that the examiners lightened the burden a little for foreigners who lacked perfect facility with the language, and who, moreover, were not going to practise in the country. At all events, I notice that for the years 1889-90, while in the entire twenty German universities 1,115 candidates received diplomas, there were at the same time 1,030 rejected. (New York Medical Record, 1891, vol. xi, p. 556.)

view is not so much the bed-side as the lecture benches, for, at least in Berlin, he rarely gets into the hospital wards. He does not read very much, and evidently sets great store for his examinations upon the careful pen-and-ink notes which he has kept of all the cases he has ever seen. In a word, he is made the subject of a constant intellectual *gavage*, in which, if you will allow the figure, the pabulum is of the best quality, and is fed to him with an unsparing hand; but it is so thoroughly predigested that very little work is left for his own intellectual powers to do, and they are likely to develop less activity than might otherwise be gained.

Conditions like the foregoing, which are not specially favorable for the student who is learning to make diagnoses, are, on the other hand, of advantage to the practitioner. From the latter point of view, the abundance of clinical material is very useful. Not only is the material very great in every European city where a large portion of the population is so poor that it must receive medical aid in sickness, but it is exceedingly available. Patients are always willing to be shown, being generally treated with fair consideration, and even when the visitor notices something lacking in this regard, it must be confessed that the patients themselves do not generally appear to be aware of the omission. Post-mortem examinations are, of course, made in all fatal cases, and hence clinical study is never subjected, as must often happen in America, to the incompleteness due to lack of pathological evidence.

The chief clinical teachers can, when they wish to illustrate any particular point, bring forward an immense amount of material. For instance, Mendel is said to have shown at one demonstration of epilepsy thirty-five patients in an hour. Certain of the medical *causes célèbres* make a living by going about from clinic to clinic, the fact that they are already under treatment with one clinical teacher making no difference in their acceptability to another. Special attractions are sometimes even sent for and fetched in a carriage like our coy voters on election day.

To work up properly such immense amounts of material involves tireless industry, and perhaps this is the most striking characteristic of the great medical teachers of Germany. The *breadth* of knowledge of such a man as Senator is something almost incomprehensible. If it be true, as has been said, that Vienna stands for specialism in medical training, it is also true that Berlin stands for breadth of medical learning. Senator's work covers not only the usual field of clinical medicine, but nervous diseases equally well, while at his polyclinic one of his most popular exercises is in connection with the diseases of children. Of course, much of the work, bacteriological, microscopical and clinical, is prepared by his assistants, but one feels that it is all done under his personal orders and supervision, while his incessant stream of publications indicates over what a long frontier of medical science he is pushing forward his explorations.

Senator's clinic at the Charité is called the Third Medical; the first is headed by Leyden, and the second by Gerhardt. These work on simultaneously, but at different hours (Gerhardt, by the way, at eight in the morning), and between them divide all that is of medical importance in the 1,800 beds of that hospital. Henoch, stricken with years, but unstricken with any other infirmity, watches over the children's wards and

the children's polyclinic. Jolly, dean of the medical faculty, lectures on neurology and psychiatry. His clinic of mental diseases, occupying some 150 beds in the new Charité, was one of the first of its kind in Europe, having been founded by Griesinger, who was the first, I think, to introduce the non-restraint method in the treatment of the insane. Westphal, who succeeded Griesinger and preceded Jolly, is said to have carried on the department for four years, and perhaps more, without ever once applying a strait-jacket to a patient.

Resisting the temptation to specify individual teachers like Bardeleben in surgery, Liebreich in materia medica, Du Bois Reymond in physiology, Bergmann, the surgeon who tracheotomized the Emperor Frederick and impaled Morell Mackenzie, now in charge of the surgical university clinic, and Olshausen, at the head of the great Frankenklinik near by, I must, nevertheless, give a word to Virchow, whose work in pathology was for years the crowning medical attraction of Berlin. He is now rector of the university, and as such gives the right hand of fellowship and the appropriate moral advice to every matriculant. The cares of administration, political activity (albeit his party has just been signally defeated), paleontological research, these and other interests, still leave him at the age of seventy-two able to give, according to the last official programme, eighteen hours per week of instruction in pathology.¹

The subjects best taught in Berlin are probably internal medicine, which I have just referred to, nervous diseases and bacteriology. The neurologists are doing a great deal of work on the anatomy of the nervous system. Where else in the world would we find going on simultaneously three elaborate courses on the anatomy of the brain? Here they are, by Waldeyer, Mendel and Siemerling. They are most admirably illustrated by fresh and hardened preparations, and especially in the case of Siemerling, by a series of stained sections of great beauty illustrating every possible level in brain or cord, and capable of demonstration by lantern and screen to a large number at once. Similar work is being done in some other laboratories, notably Mendel's and Oppenheim's, in which, in diffuse affections of the nervous system and in ascending or descending degenerations, practically the whole brain and cord of the patient is reduced to an enormous series of sections illustrating the condition at every possible plane.

In the youngest of the medical sciences, bacteriology, Berlin occupies, as is well known, a leading position.

To illustrate at once what is being done in this branch, and at the same time to serve as an example of the thoroughness with which the Germans organize and carry on scientific investigation, let us briefly describe one of the newest medical institutions of Berlin, one so new that many of my hearers who are familiar with that city have never seen it. This is the Institution for Infectious Diseases, which may be regarded as the first fruits, and perhaps thus far the most useful outcome of Koch's tuberculin discovery. In the enthusiasm which followed the announcement of tuberculin, the government promptly voted the sum necessary to carry out the enterprise, and the institution was opened in August, 1891, with Koch as

¹ With the beginning of the present semester Virchow retires from the rectorship.

director, and a large staff of skilled assistants, among them Pfeiffer, Behring and Brieger.

The Institution is situated just west of the Charité Hospital, and covers a tract of land about 650 by 200 feet in dimensions. It comprises seven wards or barracks of most approved hygienic construction, having all necessary kitchen and service rooms, baths, closets, etc., a general ward, isolating rooms, and a sun-room or sitting-room for patients who are able to be up. These provide for men, women and children suffering not only from such contagious diseases as diphtheria, but from tuberculosis in all its forms, including joint affections and lupus. One building has even been utilized for variola, while others contain puerperal fever, and even influenza-pneumonia. Rather too heterogeneous a mixture of infections, we may say, for the good of the patients treated; but a tolerably good isolation is practised, and the grouping of so many infections directly about the centre of bacteriological research gives obvious advantages for study. In the administration building is a small amphitheatre for lectures, having, among other equipments, a stereopticon and white screen for the display of microphotographs.

Behind this building stands another, which serves two important purposes: first, that of disinfection. The articles (clothing of patients and bedding from the wards) go through a regular order of rooms into and out of the steam disinfection-apparatus, and the disinfectant himself is subjected to a bath and change of clothes between the time he loads and unloads the apparatus. Under the same roof, but securely separated, is the autopsy room, where the director personally assigns to various members of his staff the work, bacteriological, chemical and microscopical, which the case demands.

For the carrying out of these researches, an old three-cornered building opposite the hospital department has been fitted up. This, the "scientific department" of the Institution, is a remarkable series of laboratories. Here are brooding-rooms, kept by automatic regulators at an even temperature of 99.5° F. Here are stalls for keeping the animals that are made the basis of experimental investigation, not only the guinea-pigs and rabbits (which since the days of bacteriology have borne away from the long-suffering frog the palm of physiological martyrdom), but also dogs, cats, doves and an occasional monkey. The animals which are already infected are kept in quarters by themselves, and, when they have finally fulfilled their mission, their bodies, together with the micro-organisms they have entertained, are annihilated by cremation in a furnace built for the purpose.

Here are rooms for microphotography, equipped with heliostats to hold the elusive Berlin sunshine and the strongest artificial lights for hours when there is no sun. Dark rooms for the development of these plates, as well as for the macrophotographs which are taken in the adjoining rooms, and by which the clinical pictures of disease, as, for example, lupus, can be perpetuated. A library and reading-room are filled with the latest publications of other workers in the same field. Finally, we notice in one of the narrow entries a door leading to the quarters where all this multifarious work is directed, with a small plate bearing the modest inscription, "R. KOCH."

The educational value of this institution is, of course, greatest to the regular staff of workers, includ-

ing those under-physicians who are detailed to this duty from the Charité. But their work is, through publication, made the property of the scientific world, while men are always going out from it as did the clever Japanese, Kitisato, to extend the work in other lands.

For the average student who goes to Berlin to study bacteriology, the Hygienic Institute is a more available place for personal practice in bacteriological work. In this building is maintained the sanitary watch and ward over the city. Regularly every two weeks are brought hither specimens of drinking-water from each of the eleven different stations which supply Berlin. These specimens are tested both chemically and bacteriologically, and if the filters (also devised in this institution) are found not to be doing their work, immediate attention is given to the matter. Here are good opportunities for practical study under the instruction of Rubner and Günther.

Courses for beginners are organized several times in a year, each course occupying all the time; that is, eight hours daily, for a month. The work is so systematized that no time is wasted. Each man makes his nutrient media, plants and dilutes his cultures, stains and examines his growths, and in general gets a *coup d'œil* at the subject, which, of course, is superficial, but which is of great service, at least in enabling one to judge of what the special workers in this department are doing. Other more advanced instruction, of course, is also given here.

In closing, I have only a few practical suggestions to make to any contemplating medical study in Germany. In the smaller universities you will probably spend less money, learn more German, see fewer cases medically, and learn far less that is of interest non-medically.

Having decided to study one or more semesters in Berlin, you can matriculate if you see fit, though it is not necessary. For this nothing is necessary but your passport as a citizen of the United States. Your medical diploma is not of the slightest use. Matriculation gives you a right to attend any "public" courses, gives you some reduction of price at theatres and concerts, and confers a certain immunity against police arrest, which may be convenient if you are sportively inclined. Neither need you be deterred by age from matriculating, for you will find among your fellow-students white-headed men in the sixties. Matriculation costs about seven dollars in money and an hour or two in time. If a matriculant, you pay through the university *quaester*; if not, in person to the respective teachers for whatever courses you elect. The usual price for a private course occupying two hours a week throughout the term is five dollars, and for a more or less number of hours in the same proportion, so that fifty dollars for a term will pretty thoroughly fill one's time, twenty hours per week of private courses and as many public courses as one can get time for. There is also usually no objection to an occasional attendance at other clinics than those for which you are regularly enrolled.

Vacation courses usually cost about the same for the four weeks that the university courses of the same number of hours per week cost for four months. Gynecological and touch courses are dearer. The number of courses offered is usually from eighty to ninety. For one of the bacteriological courses above referred to, occupying the whole of every day for a

month, the cost, including everything, is about twenty-five dollars.

Living in Berlin is cheaper than in the other great European capitals: one can live economically for not much over a dollar per day.

Women receive no recognition in any German-speaking university so far as I am aware, except Zurich. There are a few individual professors, however, who are willing to connive at the presence of women in their courses, especially if they can ascertain that some of their colleagues have committed a similar daring indiscretion.

PRELIMINARY REPORT UPON INVESTIGATIONS CONCERNING THE CONTAGIUM VIVUM OF SMALL-POX.¹

PRESENTED TO THE WORSHIPFUL COMPANY OF GROCERS, LONDON, BY STEPHEN C. MARTIN, M.D., BROOKLINE, MASS.

THE following is submitted as a partial or preliminary report of the results thus far reached in my investigations regarding the germ of cow-pox. I present it simply as a very concise statement of the facts that I have been able to demonstrate with certainty up to the present date. This will be followed by a full and complete report on the subject, as soon as I have succeeded in thoroughly elucidating certain facts, principally the morphology of the germ, which are not yet perfectly clear to my mind.

A large number and variety of bacteria obtained from vaccine virus can be grown upon the various culture media. Experimenting with gelatine, glycerine-gelatine, milk-rice, agar-agar and glycerine agar-agar, I obtained pure cultures of many varieties, none of which, however, produced cow-pox when inoculated upon the animal.

A year ago I abandoned the use of all culture media except the hardened sterilized serum of bullock's blood. With this at a constant temperature of 37.5° Centigrade, I have since conducted all my experiments. So soon as I adopted this course, I got cultures that produced cow-pox, even after passing through several generations of culture tubes. These cultures, however, were not pure, but contained quite a variety of bacteria. In every instance the blood serum was liquefied.

In November last, from a colony upon the surface of the blood serum, in a tube inoculated with heifer-transmitted cow-pox, I started a series of cultures, which have now reached the ninth generation. From both the surface growth and the condensation water of each of these cultures, I have made inoculations upon calves, and in every instance produced a perfect vesicle of cow-pox. The material "takes" with the same certainty as the lymph from the vesicle. From the vesicles produced by it upon the calf, I have vaccinated a number of children, in every case inducing vaccinia of the most perfect type, the areola not commencing until the beginning of the ninth day, a well-marked febrile reaction, and the crust not falling till the twenty-fifth day or later.

I also have a second series of cultures which I started from another specimen of vaccine lymph, that presents a precisely similar appearance, both gross and microscopical, to the first series.

The history and appearance of every culture tube,

is exactly the same. After three days in the thermostat, numerous small white colonies are to be seen upon the surface of the medium, in the course of the lines drawn by the needle, and a cloud appears in the lower part of the condensation water. Each colony occupies a little depression, which it has formed for itself, by liquefying the medium about it. Later the liquefied blood serum flows down from the colonies, carrying the growth with it, and so producing liquefaction in its course and forming white lines, occupying shallow, eroded sulci, running down into the condensation water. At the bottom of the latter, a heavy cloud settles, consisting for the most part of disintegrated blood serum, while the upper portion of the water presents a remarkably clarified appearance. When a culture is seven days old, I inoculate the next tube in the series from it and remove it from the thermostat. No growth develops upon blood serum at the temperature of the room; or upon glycerine agar-agar, either at the temperature of the room or at 37.5° Centigrade.

I have not as yet tried other culture media.

The growth is but a feeble one upon the surface of the blood serum, though such a marked change takes place in the condensation water; and in some lots of blood serum it will not grow upon the surface at all, although developing well in the water.

The bacterium varies in form according to the various conditions of its nutritive environment and the consequent rate of its development. The most constant and prevalent form is a short, fine bacillus with rounded or nearly square ends. Those parts of the culture, where the nutriment is apparently exhausted, show the same bacilli in short chains, longer bacilli, and bacilli much enlarged at one end or the middle, as if in preparation for spore formation.

Where the nutrient medium is fresh, the plant divides more rapidly and forms very short bacilli, and often even a pure micrococcus form. The latter too, is frequently seen forming chains of five or six. Chains are observed, made up partly of bacilli and partly of micrococci.

The micrococcus form is found, for the most part, in the early colonies at the upper part of the culture tube, where the nutrient medium retains its freshness by the constant draining away of the liquefied and exhausted portion. On the other hand, where this latter abounds, as in the sulci, and the pockets and condensation water, into which these drain, the bacilli greatly predominate, and the "balloon" forms appear.

Cover-glasses of the growth stain well, after a few seconds exposure to Ziehl's carbolic acid Fuchsin solution.

I have repeatedly inoculated tubes from isolated colonies that manifestly grew from a single bacterium; and the resulting cultures have invariably shown all the forms enumerated above.

My opinion now is that my tubes contain but a single plant, which assumes different forms according to the various conditions of nutrition. The typical stages of its development being a coccus, which becomes a rod; and then a "balloon," the latter being either a spore (*dauerform*) or a degeneration form. It is, of course possible, however, that there may be two separate plants present, a very small micrococcus and a bacillus. Further investigations can alone decide this point, and until I have made such, I cannot speak decidedly as to the morphology of the germ.

¹ Forwarded from the Bacteriological Laboratory, Harvard Medical School, Boston, February 1, 1891.