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THE GERM THEORY:

BY

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ETC., ETC.

Inaugural Address delivered in the Theatre of the Adelaide Hospital, introductory to the Session 1882-83.

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THE GERM THEORY.

GENTLEMEN,

We are met to-day to inaugurate a new Session, a session which I trust will be characterised in the lives of all of you as a session of work—not the spasmodic effort that brings you to the ward to see a curious case, or to the theatre, because a capital operation is about to be performed, but, the honest work which is the outcome of a steadfast purpose, a determination not to rest satisfied with the dead level of mediocrity, but, by taking advantage of every opportunity which is afforded you, to prove yourselves fit to take a foremost place in the profession which you have chosen. Some of you listening to me now, are just beginning your hospital career, unconscious of the difficulties which beset your path, ignorant of the amount of work which lies before you. I would not discourage you at the outset by conjuring up hosts of goblin shapes with which you must contend, but I would warn you that the work before you is real, and the time allotted to you all too short, to allow you to fritter away the first years of your medical studies. And if this is true in regard to your medical studies as a whole, much more true is it of your hospital work. In the wards you learn what no books can teach, and what you learn here is that which you will value most hereafter. Other work neglected may sometimes be made up for by increased diligence afterwards, but the knowledge gained by daily contact with the sick can never be picked up by a system of cramming at the last moment.

The object which you have in view is not merely to pass examinations and to become legally qualified. The profession which you have

chosen, and into which you are to-day initiated, demands more from you than that. It requires that when you have been declared by law competent to take charge of the lives of your fellow-beings, you shall not be found wanting. Experience may be gained even at this late hour, but it is paid for at a price you should never feel yourselves called on to pay—at the price of failure and remorse. In fighting with the great enemy of humanity you must be armed at every point, and now is the time when you should clothe yourselves in that armour and learn its use.

Students beginning their first medical session often look upon their hospital attendance as a matter of secondary importance. They have, perhaps, been advised to employ their first session in learning what are called the *rudiments* of medicine, and devote their time to anatomy, botany, and chemistry. Gentlemen, you cannot be too diligent in learning these subjects and acquainting yourselves thoroughly with them; but they are not the *rudiments*, they are only *accessories* to the great subject which you have to master, and you must not give them the first place. Your duty is to study the living; to defend him against disease; or, if you find him struggling helplessly in the clutches of his antagonist, to stand by him, to give him the benefit of that strength which knowledge has given to you—a knowledge which you cannot glean from books alone, which you can only learn at the bed-side. It is here only you can educate your hand, your eye, your ear. In the wards of a large general hospital like this you learn what sickness is—yes, and you learn much more; you learn sympathy with the sick; you learn patience with the sick. Rumour often speaks unkindly, because ignorantly, of the medical student. Many who have little experience of hospital life talk with a shudder of a crowd of young, thoughtless men trooping into a ward, and terrifying the patients they have to practise on. *They* little know what kindliness and sympathy is evinced by these "thoughtless young men," nor how the daily sight of suffering softens oftener than it hardens the heart; *they* never see the hollow eye brighten into a welcome, nor the gleam of gratitude shine from the lustreless eye as the *student*

goes his daily round. Yet, gentlemen, such things are not exceptional. *You* see them in the wards. There *you* learn to practise these qualities, and *you* have your reward.

In the hospital you learn to deal with disease in the numerous forms in which it presents itself, *without responsibility.* Hereafter, when you are qualified, if you have been an idler, deaf to advice and neglectful of opportunities, you will find your hands paralysed by a sense of that responsibility which the physicians and surgeons of this hospital relieve you of now. In thus addressing you, I am conscious that there are many listening to me who do not require this warning. I see before me many familiar faces, which we have been accustomed to see labouring in the wards day after day, their whole soul engrossed in the work they have taken in hand, and who will soon be ready, with those who have already passed through the ordeal of a final examination, to go out into the world and to carry the fame of the Adelaide Hospital far beyond even the limits of these islands.

Gentlemen, this hospital cannot boast an ancient pedigree. One of its founders to-day occupies the Presidential chair of the Royal College of Surgeons, the senior surgeon to this hospital. But it can boast far more than antiquity, it can boast a youthfulnes and adolescence full of that vigour which has placed it in the enviable position it holds to-day. As a teaching institution, it aims at producing the best work, and that it does not fail in its aim is evinced by the foremost place which our students take at their various examinations, and by the positions in the world which they afterwards occupy. It is no novelty to hear that the first place, and sometimes the first two or three places at the University Examinations have been secured by Adelaide men. But, gentlemen, I do not ask you to rest satisfied with the laurels of others. To you who are listening to me to-day belongs the privilege of emulating your predecessors, and adding fresh wreaths of victory to theirs. It is no light task which is set before you, but one which patient perseverance and a lively interest in your work will accomplish. In the name of my colleagues, I bid you welcome to this hospital, and I assure you

that you will always find us ready to co-operate with you in making the best use of the session which is now beginning.

I will not delay you longer to-day in urging upon you the principles which should actuate you in the study of your profession. Keep constantly before you the object which you should aim at, and recognise in it the highest privilege accorded to man, that of being a benefactor to your race. Remember that all suffering humanity, if he require your aid, is your neighbour; no matter what his religion may be, be he Christian or be he heathen, no matter to what clime he belongs, even though he be one of a nation with which your nation has no dealings, still he stands in the same relation to you that the Jew of old did to the Samaritan: he lies in your path wounded, perhaps half-dead. The command lies upon you with the urgent emphasis as of old: "Go and do thou likewise."

If you are actuated by such motives you will lose no opportunity to render yourselves fitted to fulfil such a high vocation. To-day you enrol yourselves as students in a profession, than which no other has a nobler aim. As you embark on the unknown and difficult seas of learning which lie before you, keep this as the beacon light to which you should steer. If you would prosper in your profession, if you would do the greatest amount of good in it, you must make yourselves fitted to the best of your abilities, to undertake its duties. The doctrine of evolution will prove correct in your case. The fittest will survive. The idler and the incompetent will eventually go the wall, or must rest satisfied with the humbler spheres of work. The men in the past who have raised themselves to highest eminence were not the men whom fortune bore along on her fickle bosom; they were men who worked hard and spared no pains to climb the ladder; and step by step they gained each rung, till they had reached the highest. This is the way too you must rise. Fortune does indeed often favour the brave, but to benefit by her favour, you must be ever ready to avail yourselves of it, when her wheel comes round to you.

Gentlemen, you will find the study of medicine and surgery,

perhaps, the most interesting of all professional studies. No doubt at first you will find the earlier portions of your work often irksome and dreary. Here you will require the greatest amount of energy and perseverance. Once you have mastered the foundations and begin to get an insight into the marvellous intricacies of the superstructure, you will find that the toil you have expended is well repaid. You will find as you advance that it is not all composed of a series of hard facts which you must learn by heart. These facts must be learned; they are to medicine what grammar is to a language. But if you have the patience to master these, you will find volumes of absorbing interest ready at your hand, volumes which year by year grow more in interest as the science of our profession progresses.

Pre-eminent among the rapid strides which medicine and surgery have lately made—progress which will mark the nineteenth century as the most eventful in their history—we find a discovery which has done much to revolutionise both branches of our profession, and one which promises to show us that, far as we have gone, we are still but on the threshold, still but as children playing on the beach with pebbles, and standing on the shore of an unknown and boundless ocean.

I allude to the germ theory. The term does not convey our present state of knowledge correctly. The term "theory" would seem to imply that we are now furnished with an explanation of certain changes which occur in organic nature, which is theoretically sound. At one time the fact that the earth was round, and revolved upon its own axis in twenty-four hours, was accepted only as a "theory," which was one way of explaining the phenomena of night and day. This is no longer a theory, and like it the germ theory has been established by incontrovertible evidence to be a fact.

Hostile critics have brought every refinement of scientific research to bear upon it, but it has stood the trial, whether of experiment, or of the microscope, or of the electric beam, and has emerged from the ordeal no longer a theory but an established fact.

In medicine it is now almost universally accepted. Fevers are

no longer looked upon as smouldering fires that burn up the system, or as humours devouring the frame, but we now know that they are the result of a living poison that has been sown in the system somehow, that this poison has grown and multiplied during the stage which is known as the stage of incubation, until it has poisoned the whole being. Each fever is produced by its own poison; and wherever that poison is sown and develops, there it produces its inevitable consequences. "As surely," says Professor Tyndall, "as a thistle rises from a thistle seed, as surely as the fig comes from the fig, the grape from the grape, the thorn from the thorn, so surely will the typhoid virus increase and multiply into typhoid fever, the scarlatina virus into scarlatina, the small-pox virus into small-pox. What is the conclusion that suggests itself here? It is this—that the thing which we vaguely call a virus, is to all intents and purposes a seed."

The application of this theory to surgery is one of the most burning questions of the day, and one of the most important. You see, day by day, both in this theatre and in the wards, the germ theory guiding our practice, and my present object is to show that this practice is not empirical. The germ theory maintains that in the surgical treatment of wounds, putrefaction is to be avoided by keeping the wounds free from living organisms. As these organisms are stated to act as local or general poisons, the method by which they are excluded is called the *antiseptic method.*

I hope to show you to-day, gentlemen, that this principle is sound, because it is founded on facts; that every step in the theory is proved to demonstration, and that, to deny the soundness of the principle itself, is as inconsistent with common intelligence as it would be in the present day to deny the law of gravity among the heavenly bodies. Do not mistake me, gentlemen; I do not say that "the antiseptic method according to Lister" is thus beyond all criticism. This is only one of the methods of putting the antiseptic treatment of wounds in practice. It is the one most generally adopted, because it provides in the most thorough way known at present against the possible entrance of septic germs

into wounds; and I unhesitatingly affirm that it is *the* method of all others which gives the desired results, provided that it be thoroughly carried out. "To apply the antiseptic treatment with success," says Professor Lister, "the surgeon must be interpenetrated with the conviction that the germ theory of putrefaction is true."

It is acknowledged on all sides that what we call putrefaction is nothing more nor less than a form of fermentation. It is scarcely necessary to remind you that fermentation was employed in the manufacture of wine as early as the days of Noah. Tyndall informs us that beer was described as the "wine of barley" nearly four hundred years before Christ. Fermentation has thus been made use of for centuries, but the manner in which the process occurred was ever a mystery; "putrefying sores" are stamped with the antiquity of Holy Writ, yet the agencies at work in producing putrefaction in wounds remained unrevealed.

Let me describe to you what takes place in perhaps the best-known instance of fermentation, that employed in the manufacture of beer. You are aware that "malt" is prepared by steeping barley in water, draining off the supernatant fluid, and then allowing the moistened seed to germinate by keeping it at a suitable temperature. When this germinated seed is dried it is called malt. This malt is then mashed up in warm water and boiled with hops. The infusion which thus results is drawn off and allowed to cool. The brewer now mixes yeast with this organic fluid, and places it in vessels with only one aperture open to the air. The mixture soon begins to froth and to foam, and this brown foam in a short time pours in abundance from the vessels. Examine a little of it with the microscope. It is yeast. Collect it now and weigh it; you find four or five times the quantity which was originally introduced. This remarkable phenomenon, though observed for ages, remained shrouded in mystery till the year 1835. It was then discovered by Cagniard de la Tour in France, and Schwann in Germany, that the active principle of yeast consisted in a minute plant, which they could see growing and sprouting in the field of

the microscope. Here then is an organic fluid, an infusion of malt. Into this fluid the brewer deliberately introduces a certain living organism. This organism, the yeast plant, at once grows, develops, multiplies. It requires sustenance—its food is oxygen. Submerged in the infusion of malt, it can get no nourishment from the air. It falls back upon the organic fluid. It robs it of its oxygen, and to do this it must decompose it. As a result of this decomposition, alcohol and carbonic-acid gas are formed. In other words, fermentation has taken place, and beer is the result. If no germs of this yeast plant were allowed to find access into this fluid, if they were excluded altogether, this fermentation would not take place. Thus have brewers for centuries been putting the germ theory into practice, without understanding its *modus operandi.*

Now, gentlemen, suppose, instead of malt, we take some animal fluid—say an infusion of beef, ordinary beef-tea—and place it in a vessel exposed to the air. In a few days it undergoes certain changes, with which you are all familiar. It has at first been quite clear and odourless; it soon becomes cloudy and muddy, a film forms over the top of it, and then it gradually assumes a most offensive smell—in fact, it putrefies. Take a little of this muddy fluid and examine it under a microscope. You will find it swarming with small bodies, which move about in the field of the microscope, and if you watch them carefully for some time, you will see them growing, dividing, and multiplying, giving rise to numerous similar bodies, much in the same way as the yeast plant was observed to grow. In fact, they are living organisms. Whence do they arise? They are always present in decomposing fluids; while if the fluid be protected by certain means, that fluid will remain clear and odourless for any length of time; it will not putrefy. We answer—these organisms find their way into the infusion of beef from outside. Let me shortly indicate to you the methods of proof by which this assertion is supported.

You have often noticed, I am sure, the effect of a strong sunbeam coming into a room. You have seen the myriads of minute particles dancing in the ray. These motes floating in the air are more

readily seen if the sunbeam enter a darkened room through a hole in the shutter. Professor Tyndall employs for this purpose the electric beam. To make it more powerful he condenses it by making it pass through a powerful lens into a darkened chamber. If with such a beam we repeat his experiment, and hold beneath it a spirit lamp, what do we observe? We see "curious wreaths of darkness resembling an intensely black smoke" passing up through the beam of light. Is this blackness smoke? Use instead of a spirit lamp a hot ball of copper, you will see the same result. Hold beneath the beam a flask filled with hot water, currents of blackness will be seen rising through the brightness of the ray. This black vapour cannot, then, be smoke. What is it? It is air which contains no means of scattering the light as it passes through it, and which, therefore, renders the light invisible. The particles which were seen floating in the beam have been removed or destroyed by the heat. Now, inorganic matter could not be thus burnt out of the air, for it is non-combustible. These floating particles which are revealed by the beam must be organic. Heat has destroyed them. Here is a fact of the first importance, and thus Pasteur accounts for it:—"The dust which we observe on the surface of all bodies is constantly being affected by currents of air, which must take up the lighter particles, amongst which we doubtless find the preference given to organised corpuscles, eggs, or spores, which are generally not so heavy as mineral particles." We see, then, that the air is full of floating particles of matter, that these particles are organic, and that the air can be purified from them by the aid of heat. But the air can be purified of these motes in another way. If the air in a room be undisturbed, if it be kept absolutely at rest, these minute particles will gradually subside and adhere to the floor and sides of the room, and the air will gradually become pure. These are conditions which it would be almost impossible to carry out on a large scale, but that such is a fact is shown in a beautiful experiment by Prof. Tyndall. He gets a large square box, with a glass front. The back and sides, top and bottom, are

wooden. Two small glass windows are situated one at each side facing each other. Through these windows he allows a condensed electric beam to pass. The inside of the box is smeared with glycerine. Test tubes are fitted air-tight into holes in the bottom of the box, their open ends being within the box. A pipette passes through the top, by means of which fluids can be introduced when required into the test tubes. The door of the box being closed, the electric light is so arranged that the condensed beam, passing in at one of the side windows, emerges at the window opposite. If you look in through the glass front, its track is seen to be eminently brilliant, and the dust in the air of the box is at once brought into view. Now, this box is allowed to remain at perfect rest for three days. If it be examined during the interval, the beam inside the box will be seen to have faded in its intensity. On the third day, *within* the box it has completely disappeared, whilst *outside* the box it is as bright as ever. The floating particles which were rendered visible by the beam of light, and which, in their turn, rendered the light visible, had vanished. They had subsided and adhered to the glycerine. The air inside the box was "optically pure."

Now, suppose we introduce into the test tubes some infusion of beef, or any other organic fluid. This, from contact with the air outside the box, is contaminated with the dust of the air. We have seen that heat will destroy these motes. To purify it, then, the test tubes containing this fluid are boiled by means of an oil bath. What, then, is the condition of affairs? We have test tubes whose open mouths are exposed to the air inside the box. This air, the electric beam tells us, is free of dust. The test tubes contain an organic fluid which has been boiled so as to destroy all motes which could have made their way into this fluid. Now, mark the result. *The beef infusion will remain clear and pure for months, whilst the same fluid in test tubes exposed to ordinary air will become foul in a few days.* What do we learn from this? Do we not learn that purified air will not cause putrefaction; that the living bodies which we see under the microscope swarming in a

putrefying fluid, and which we call bacteria, do not arise in that fluid spontaneously, but come from without? Do we not also learn that the germs from which these bacteria are developed are floating in the air?

The same results have been attained in another way by Mr. Lister. He employs an air-tight iron box, in one side of which is a door, round the margin of which cotton wool is tightly packed, so that no air can get into or out of the box without passing through the cotton wool. Air passing thus through cotton wool is found to be effectually filtered of its motes. The box is heated for two hours at a sufficiently high temperature to destroy completely all the organic material floating in the air or adhering to the sides of the box. It is then allowed to cool. As the air in the box cools, it contracts, and fresh air is sucked into the box through the cotton wool, which filters it. Bottles containing organic fluids placed inside this box, and heated in the manner described, are rendered pure, and if their open mouths be protected by caps of cotton wool, before removal from the box, they will remain clear and unaltered for months and years.

Now, suppose we take one of these flasks which has been kept for months without undergoing any change, and which the microscope proves to you contains no bacteria; suppose you open it for a few minutes in the ordinary air of a room, or suppose you dip a finger into it, or add a drop of any ordinary fluid to it, such as water, what will be the effect? It will more or less rapidly decompose, and in a few days the microscope will reveal to you that it is swarming with organic life. The least contact with ordinary dust will effect this change.

Now, let me show you another way of rendering the air inert—of destroying its power of producing putrefaction. When Mr. Lister had purified a flask of organic fluid by means of his hot box, he often required to transfer some of this fluid into a smaller vessel for the purpose of experimentation. The process by which this was accomplished is somewhat complicated, and required an amount of care which rendered it extremely difficult. I need

not enter into the details. Mr. Watson Cheyne found that he could dispense with many of these details by a simple process. Let me quote his own words. He says:—"In the small room in which most of my experiments were done, it was almost impossible for me to transfer fluids from one flask to another, by Mr. Lister's method, without contamination and subsequent fermentation; but if I performed the same manipulations in a spray of about 1 in 30, carbolic acid and water, I could transfer all sorts of fluids with ease from one flask to another without any risk, even though done in the most leisurely manner." It would thus appear, gentlemen, that there are certain substances, such as carbolic acid, which act upon the air, and render it innocuous. How does the spray so act? It has been contended by some of the opponents of Listerism that carbolic acid does not affect organic germs injuriously. Let us put this assertion to the test. Take a drop of any putrefying fluid, and place it under the microscope, you will see the swarms of bacteria moving about in every direction—some leisurely, some in a most active manner. Now, to the margin of the cover glass apply a drop of carbolic lotion (1 in 20); at once all the movements cease, and the bacteria do not again recover their power of motion. They have been killed. It is thus established beyond question that the air, when impregnated with carbolic-acid spray, is rendered harmless, because its power of producing fermentation has been destroyed by the germicidal properties of carbolic acid.

So far, gentlemen, we have referred to organic fluids, instanced by infusion of beef; and we have shown that when this fluid is boiled and kept in a pure flask, so that no dust or contaminating matter can get access to it, it will remain pure. This is equally true of all organic fluids; it is true of blood, of milk, and of pus.

Let me call your attention for a few minutes to a few facts relative to the behaviour of organic fluids with respect to germs. In agriculture it is well known that the vigour of a crop—its productiveness, depends not only on the quality of the seed, but also and in a more marked degree on the quality of the soil in which the

seed is sown. The fruitfulness of the sown grain depends on whether the land is light or rich, whether it is a soil that is suitable to a particular crop or whether it is not. Now, exactly the same conditions hold in the case of germs sown in organic fluids. The soil in which they are sown may be particularly unsuitable for the development of these germs, and consequently for the production of putrefaction, or, on the other hand, the fluid may be very favourable.

Blood has frequently been referred to as having an inherent tendency to decompose, but this is not the case. Yet a mixture of blood and water is exceedingly putrescible. Now let us see what happens when these fluids are protected from germs. Mr. Lister has obtained blood directly from the jugular vein of an ox. The vein was exposed antiseptically, and divided. The blood flowed into a purified flask, the mouth of which was subsequently closed with a cotton cap. Blood so obtained can be kept for any length of time without undergoing any putrefactive change, even though its putrescibility be greatly increased by its dilution with water. Moreover, this shows us that the blood, circulating through our bodies, is in the normal state free from germs; it contains no inherent properties which would lead to decomposition. This is also true of milk. This latter is a fluid which it has been found most difficult to keep pure. The most elaborate precautions often failed. Mr. Watson Cheyne has found carbolic lotion and the spray a comparatively efficient method. The udder of the cow and the hands of the milkmaid were washed with carbolic lotion (1 in 20); purified flasks were uncorked and filled with milk under the spray. Though some of the experiments failed, owing to the difficulties of carrying out the details thoroughly under trying circumstances, several of the flasks when uncorked after ten months were found to have remained unchanged, whilst flasks which were filled at the same time, but without these precautions, fermented in a few days.

Gentlemen, I need not multiply proofs; I have endeavoured to lead you, step by step, from a condition of agnosticism to a firm faith in the germ theory, by the cold logic alone of incontrovertible facts.

But one step remains, and that is to show you that what is true in regard to organic fluids in flasks or test tubes, is as true in regard to fluids in the living body. Let me detail to you a circumstance which to my mind is conclusive on this point, and which, without the aid of the germ theory, is inexplicable. Suppose a man meets with an accident which breaks his ribs, and that as a consequence blood escapes into the pleural cavity—that is, into the space between the lungs and the ribs. Suppose air gets in and mixes with this blood. It may get in in one of two ways. On the one hand, the injury which broke the rib may have inflicted a wound on the soft parts covering the ribs, so that the air communicates directly through the chest wall with the blood in the pleural cavity. What will be the result? The experience of the surgeon, whether he believe in the germ theory or not, is that that blood will assuredly undergo putrefaction, with all its attendant dangers. Now, on the other hand, suppose that the chest wall has not been punctured at all, but that the sharp end of the broken rib has injured the lung so that, at every breath, air is pumped into the pleural cavity from the lung and mixes with the blood. Will the blood under these circumstances decompose? *It will not.* It will remain pure, and, in all probability, be absorbed. This "was to me a complete mystery," says Professor Lister, "until I heard of the germ theory of putrefaction, when it at once occurred to me that it was only natural that air should be filtered of germs by the air passages, one of whose offices is to arrest inhaled particles of dust, and prevent them from entering the air cells."

Professor Tyndall has shown, by means of the electric beam, that this hypothesis is not only *natural*, but that it is perfectly *certain*. By breathing out across the condensed electric beam, "an obscure disc appears in the beam, the darkness of which increases, until finally, towards the end of the expiration the beam is, as it were, pierced by an intensely black hole, in which no particles whatever can be discerned. The deeper air of the lungs is thus proved to be absolutely free from suspended matter."

I have already called your attention to this scientific fact, that a

ray of light, when it passes through "optically pure" air—that is, air which has been freed from all particles of dust which have been floating in it—becomes invisible. *Vice versâ*, if a ray of light passing through air becomes invisible, that air contains no particles suspended in it. Hence the air breathed out of the lungs, *at the end* of expiration, must be perfectly pure, as it fails to scatter the light. The fine air tubes in the lungs have effectually filtered and purified it. That such air entering the pleural cavity containing blood is powerless to produce putrefaction, follows as a necessity on the germ theory, and we find by experience that such is the case.

Again, in certain cases, it becomes the duty of the surgeon to make an opening through the chest wall into the pleural cavity. Suppose, for instance, we have to deal with a case of empyema, a case in which a large quantity of pus has collected within the chest. I need not tell you that it is of the greatest importance to get rid of this pus, and, therefore, it becomes imperative for the surgeon to make an opening through the chest wall. As soon as this is done, the air of the room is sucked in through this opening at every inspiration. Now, under ordinary circumstances, the pus, which at first was pure and sweet, would, as a necessary consequence, gradually become fœtid and undergo putrefaction. We have seen that this putrefaction is brought about by the agencies of germs, which the unpurified air carries with it into the pus. The air enters without undergoing the purifying process which filtration through the lungs would accomplish. We must provide some other means of purifying it here. We make use of the carbolic spray. In such a case Mr. Watson-Cheyne has employed it, and day by day he has examined the pus which flowed out through the drainage tube. For over a month after the chest wall was opened, a drainage tube inserted, and the wound dressed by Lister's method, the pus remained perfectly fresh, and the microscope failed to detect any trace of organisms in it. And this is the experience of those surgeons who have used this method honestly and perseveringly; of those who, undaunted by failure, have worked *through* failure to success, because, with the humility of the truth-seeker, they believed

that when they failed, the fault lay not in the principle of antiseptic surgery, but in *their* method of applying it.

Is further proof required to convince you that the germ theory of putrefaction is true, and that we have in carbolic acid a means capable of destroying the unseen, yet ever present, organisms which throng the air? If you still doubt, I ask you to examine a case in which some large wound, such as an amputation, has been allowed to remain exposed to the ordinary air in the ward. The wound in all probability is healing slowly, there is an abundant discharge of pus, most likely fœtid. Take one drop of it, place it under the microscope, you will see that it swarms with bacteria—bodies similar to those observed in putrefying organic fluids. Look at a precisely similar wound, which has been treated from the beginning in the most careful way by Lister's method; it is healing rapidly; a few days completes the process; there is no pus; the discharge is thin and clear and odourless; test it with the microscope; you will find no trace of bacteria in it.

I have been able only to give you instances of proof to-day, but I can assure you that behind these instances, conclusive in themselves, is an overwhelming host of other proofs as incontrovertible as they.

I have alluded chiefly to the spray, because it serves to illustrate the principle on which the whole system of antiseptic surgery is based. But I cannot now enter into the details of this method, which we owe to Professor Lister; you will learn them better by intelligently studying the practice of them in this hospital.

Gentlemen, as I hope that each of you hereafter, when you enter upon the practice of your profession, will adopt this method, with the firm conviction that the welfare of your patient demands it, and I believe you will, let me tell you the secret of success. The secret is *thoroughness*. "Interpenetrated with the conviction that the germ theory of putrefaction is true," look upon everything which comes near your wound as though you could see bacteria upon it, unless it has been previously purified. Should your hands, as you operate, leave the antiseptic atmosphere of the

spray for a moment, believe that in that moment your aërial enemies have settled upon them. Act always on the defensive, and because you cannot *see* your enemies, believe them omnipresent. If you act thus in faith your success will not be fitful. You will effect what you aim at. You will see wounds, and those of the most dangerous kind, heal in a few days, without fever, without suppuration, without blood-poisoning—results which our predecessors would have looked for as the highest goal to be reached in surgery, but which they hardly hoped would ever be attained.

Gentlemen, if you believe in the germ theory, and believe in it you must unless your minds are blinded by prejudice, you must, as a natural consequence, adopt the antiseptic treatment of wounds. Do not be deceived by names. You will hear *this* method or *that* method of treating wounds lauded, and many of them have undoubtedly given good results, but when you come to look into them their value consists in this, that they all aim, in some degree or other, at *interfering* with the growth and development of germs which have made their way into the wound. They do not aim at totally excluding them. Some propose to neutralise their effect with antiseptic lotions; some hope that they will make their exit without doing harm, if they open a way for them, by means of free drainage. Now the value of any one of these methods is in proportion to the degree in which the method acts antiseptically and no more. Underneath all these methods lies the tacit acknowledgment of the germ theory. If you take your stand on this theory, and accept it as a fact established by undeniable proofs, I say the logical consequence of it is, that you will rest satisfied with no system of treating wounds which does not aim at keeping the breeders of putrefaction out of them altogether. The carbolic spray may fall into disuse, carbolic acid itself may be given up in a few years, but never till a substitute is found—a germicide as potent as carbolic acid, which can be proved to be free from all objections. Lister's method may be improved, but the principle on which that method is based will be as undying as the name of its great author.

Gentlemen, as believers in the germ theory of putrefaction, and

in the antiseptic treatment of wounds, you will meet with plenty of opposition, and you must be prepared to meet it. Be sure of the ground on which you stand, and you need not fear the objections which are raised to your belief by *honest* critics. You will be met by such questions as these:—How do you account for wounds exposed to the air sometimes healing by first intention without suppuration? How do you account for abscesses giving rise to blood-poisoning which have never been opened or exposed to the air? How is it that bacteria may be found in abscesses originating internally, and yet no blood-poisoning ensue?

To such questions as these you will often find it exceedingly difficult to reply; yet answers to these questions have already been offered, which to most minds are perfectly satisfactory. Yet allow for the moment that these problems and the like cannot be satisfactorily solved to-day, I ask you how does this affect the point at issue? How does it affect the germ theory? It only shows us that much as we know of the properties, the mode of spreading, and the life-history of these microscopic germs, there is a great deal we have still to learn. Such objections amount only to this. It has been proved that germs in the air are the cause of putrefactive changes taking place, and that if they can be excluded then no such changes occur; but it cannot be *proved* with the same absolute certainty why bacteria sometimes, and that but rarely, fail to cause putrefaction; nor can it be *demonstrated* how they make their way into deep-seated abscesses. We should indeed have made progress in the study of germ-life if we could to-day explain all the phenomena which arise.

Gentlemen, I cannot conclude to-day without briefly showing you some of the results which the germ theory has attained when applied by such men as Pasteur, Lister, and Koch—men whose scientific acumen will allow them to accept no proposition till they have examined it, and satisfied themselves as to the foundation on which it stands. These men have accepted the germ theory, not as the outcome of an enthusiastic imagination, but as the legitimate offspring of a logical sequence. They have tested its value in the

vegetable kingdom, and have been rewarded by the results; they have applied it to animals, and they have found that it has not failed. They have brought it to bear as an untried weapon in fighting against diseases which have ravaged humanity; they have found it still victorious. Let me briefly show you how this theory has been applied, and how it has worked. The discovery of the yeast plant was the first glimmer of light which shone on the much-vexed question of fermentation. Pasteur followed this up. An opportunity of testing this new doctrine soon occurred. A plague had stricken one of the most prolific of French industries. Some unknown cause was at work, which threatened to ruin the wine trade of his country. The wine would not keep; especially when exported it became acid or bitter. Pasteur took the matter in hand. He soon discovered that the cause of these deteriorations were organic germs. Pursuing his investigations further, he found that these organisms could be destroyed by heat, and, moreover, that the temperature necessary to destroy them was so low, 122° F., that it did not affect the wine. This knowledge was applied. When the wine was heated to this degree no change subsequently took place in it. The germs which made it undergo this acid fermentation were recognised and killed, and the French commerce in wine was saved.

Another of the richest trades of France was threatened with destruction. A plague called pébrine, which attacked the silk-worms, had raged for fifteen years. Multitudes of them died, and those that survived supplied but a small fraction of the usual quantity of silk. It will give you an idea of the extent of the mischief when I tell you that in one year it entailed a loss of a hundred million francs. All kinds of theories were started to account for the disease, and every variety of nostrum was prescribed. They all failed. Pasteur undertook the task of tracing the disease to its origin. He found it was the work of a parasite, a minute living organism, which in its earlier stages of growth defied even the power of the microscope. For several years he followed the life-history of the silk-worm, from the egg to the full-grown worm,

then to the chrysalis, and finally to the moth which again lays the eggs of a succeeding generation. Side by side he traced the parasite, found it contaminating the leaves on which the silk-worm fed, and thus introducing itself into the intestinal tract of the worm. Then it invaded the sack which contained the material from which the silk-worm spun its cocoon. Growing and multiplying here, the sack soon became filled with these organisms. The infected worm would spin automatically, but it had no material, and its labour was fruitless. Pasteur applied himself to the remedy. He discovered the exact period in the development of the worm when the poisonous germ might be destroyed. He succeeded, and saved the silk industry to France, and millions of money to her exchequer. During the whole period of his investigations, working for the benefit of his nation, he had to contend not only with the disease he was sifting, but with the most virulent opposition. In his work on Silk-worms he says—"Since the commencement of these researches I have been constantly exposed to the most obstinate and unjust contradictions, but I have made it a duty to leave no trace of these conflicts in this book."

In the application of the germ theory to the surgical treatment of wounds, Professor Lister might well use these words. Like Pasteur, however, he has been rewarded by more than the uncertain eulogies of his fellow-workers, he has been rewarded by success. Surgery in the last few years has been revolutionised, and it is no exaggeration to say that, in so short a time, never has there been such progress made. The antiseptic method has introduced to surgery operations which formerly were unjustifiable. Now they are attended with little, if any, risk. Hospital gangrene, erysipelas, and blood-poisoning, at one time rampant, have nearly ceased to exist. What does Professor Nussbaum tell us was the condition of the hospital at Munich before he introduced Listerism, and its condition now? He tells us that previous to the use of the antiseptic method, "pyæmia always flourished there; that since 1872 hospital gangrene has been a constant though unwelcome guest, so that in one year 80 per cent. of all wounds were attacked."

He speaks of erysipelas and hospital gastritis as so prevalent in the building, "that it was the exception for a patient to escape an attack. The hospital was a veritable pest-house." Here then was a fitting soil on which to labour. Here was an opportunity for putting theory to test. He introduced the Listerian method. Every case of wound was treated on strict antiseptic principles. Since then he tells us he has not had one case of hospital gangrene (there having been previously 80 per cent.), not one case of blood-poisoning; and he has abolished erysipelas altogether; and this change has continued uninterrupted for five years.

But it is not in surgery alone that the germ theory has been victorious. As each year passes some new discovery reveals to us the hidden workers of disease. Fever poisons and the like have been called viruses; we can now recognise their forms as specific germs. Not long ago diphtheria was added to the list. The organism which caused it, a form of what is called the micrococcus, has been recognised, and its life-history scanned. Scientific practitioners abroad have been attacking it with antiseptics—Letzerich with benzoate of soda, Oertel with carbolic acid. Soon, I have no doubt, its vulnerable point will be struck. In Germany and Russia a disease, always fatal, called splenic fever, caused havoc among cattle. In the single district of Novgorod, in three years, it destroyed over 56,000 horses, cows and sheep. Its ravages reached even to the people in this district; over 500 perished during the same period of this disease. Koch examined the blood of these animals; he found it swarming with organisms, and with their spores or seeds. He tested the vitality of these germs. He dried some of the blood containing the spores, and made it into a dust, then he wet it again and dried it, and subjected it to a variety of other tests. He kept it for four years, and then inoculated mice with it. The spores had not lost any of their vitality. They were as active as when first they were procured. All the mice died of splenic fever. Surely when the first streaks of light have already dawned on the cause of the disease, we have not long to wait till the day breaks on its cure.

There is scarcely a malady which has hitherto so baffled the skill of the physician, and mocked his every effort, as the dreaded disease, hydrophobia; yet the germ theory promises to crush it beneath our feet. It has shown the insidious poison which lurks within the system long before it attacks its victim. This period of apparent inaction is seized. Experiments are now being made to show whether, by a process of intravenous injection, after the victim has been bitten, he may not be protected against the dreaded outburst of the disease. In the early part of this year, M. Galtier read a communication on this subject before the "Académie des Sciences," which is full of import. In it he describes how he had injected the virus of hydrophobia into the veins of numerous animals (sheep and dogs). Some time subsequently he inoculated some of the same virus beneath the skin of the same animals. He never saw it followed by hydrophobia, although this inoculation was invariably followed by this dreaded disease in animals which had not previously been subjected to such intravenous injections. Again, he inoculated the virus of rabies beneath the skin of two sheep and one dog; then in twenty-four hours he injected the poison into the veins of each animal. Hydrophobia never declared itself in any one of these, although it subsequently appeared in the case of similar animals, which had only received the poison beneath the skin. Thus, it would appear that the poison of rabies or hydrophobia, when injected into the veins, is not only innocuous, but that it even protects the animal against the development of the poison, when introduced beneath the skin. And, moreover, that the injection of the virus protects even when it has not been resorted to for twenty-four hours subsequent to the hypodermic inoculation. The practical importance of these experiments cannot be exaggerated. The prospect which they promise to open up before us is that by injecting the virus of rabies into the veins of a person who has been bitten by a mad dog, where such injection is feasible, he need no longer look forward with dread to the outburst of a disease which renders even death itself a welcome release. If this is established, we may claim for the germ theory, enlightened

by experimental physiology, one of the greatest triumphs it can attain.

The germ theory has recently been brought to bear on tubercular diseases. On the 24th of March last, Koch delivered an address at Berlin, in which he struck a chord which has vibrated through the whole world. It deals with a disease which, in point of mortality, stands at the head of all infective diseases. "If," he says, "the seriousness of a malady be measured by the number of its victims, then the most dreaded pests which have hitherto ravaged the world, plague and cholera included, must stand far behind the one now under consideration." He makes the startling statement that one-seventh of the deaths of the human race are due to tubercular disease, while fully one-third of those who die in active middle age are carried off by the same cause. By a series of elaborate experiments, Koch has at last discovered the source of this terrible scourge—the *fons et origo mali.* What is it? A micro-organism. He has isolated it, cultivated it, and inoculated with it. He has traced it through the stages of its existence. Is it too much to expect that the day is not far off when this malady, now placed in the long list of preventable diseases, will itself be prevented? That as knowledge increases, and earnest workers still labour on, some means shall be found for striking down the enemy now dragged to light—a foe which eluded every attempt at attack, because it was unseen and unknown. "It is in the power of man," says Pasteur, "to banish parasitic diseases from the surface of the globe, if, as I am convinced, the doctrine of spontaneous generation is a chimera."

This is no vain boast. He has shown us how it is to be done in the brilliant results he has already attained. Within the past year he has added another proof. He discovered the germs or spores which caused an epidemic of typhoid fever among horses in Paris. He experimented with these germs, and found that a certain line of treatment rendered them sterile, or, in other words, killed them. He then got some fresh germs; he nursed them and doctored them till he reduced them to the verge of death. Seizing this critical

moment, he subjected them to an invigorating regimen. They revived, but their power of mischief was almost completely destroyed. With these he inoculates. This inoculation produces a modified and much milder form of the disease, which effectually shields from the severer type. This "attenuated" virus, as it is called, acts as the vaccine of the original poison.

Such are some of the developments of the germ theory, and such are the rich fields it opens up before us. The privilege is accorded to you to go in and possess them. The great Alexander wept because there were no worlds left for him to conquer. You need not pause and weep, or share his regret. Boundless regions of unknown wealth lie before you, rich in blessings for mankind. But you must be prepared to conquer them. It behoves you to rise and gird on your sword—the weapon of honest industry, kept bright by daily use, untarnished by idleness, unblunted by prejudice.

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