unavoidable. The case affords another illustration of the impunity with which the peritoneum may be opened, and suggests the inquiry whether, in any case presenting unusual difficulties in the operation of tying the iliac arteries by the customary method, the one here adopted might not deserve the preference. I have witnessed fatal cases, in which I thought that death resulted from extensive separation of the peritoneum, combined with the stretching and bruising of the tissues found necessary to expose the artery; and I believe that such cases would have a better chance of success if the artery were directly exposed by a careful division of the peritoneum in the median line. The dangers attending such a procedure must, I think, be greatly lessened by the employment of an antiseptic animal ligature; and the ease which I have narrated proves that catgut, if properly selected and prepared, is capable of permanently arresting the circulation through the largest artery which is likely to require ligation.

ARTICLE VI.

WHAT IS THE EXPLANATION OF THE PROTECTION FROM SUBSEQUENT ATTACKS, RESULTING FROM AN ATTACK OF CERTAIN DISEASES, AND OF THE PROTECTIVE INFLUENCE OF VACCINATION AGAINST SMALLPOX?

By GEORGE M. STERNBERG, M.D., Surgeon U. S. A.

IN a majority, if not in all, of those diseases in which one attack is protective, we have an increase of the specific poison within the bodies of the sick, as is proved by the fact that the disease is communicated by them. The hypothesis which is, perhaps, most in favour with medical writers of the present day to account for the protection furnished by a single attack of these contagious maladies, is that which assumes that some material present in the blood or tissues of unprotected individuals is exhausted during the attack, and that when again exposed to the poison, the individual is no longer susceptible to its influence, as the pabulum necessary for its increase is no longer present in his system.

This hypothesis is sustained by Pasteur (*Sur le Choléra des Poules*, *Comptes Rendus Acad. des Sc.*, xe. pp. 952–958) to account for the protection afforded by inoculation with "attenuated virus"—compared to vaccination—which fowls enjoy from the disease known as chicken cholera. As the arguments used by Pasteur, based upon carefully conducted experiments, are probably the strongest that could be adduced in favour of the hypothesis referred to, I shall give them in detail, and will afterwards state my reasons for venturing to differ from this distinguished savant, and the facts which induce me to give preference to a different explanation of the phenomenon in question. The following are the conclusions of Pasteur:—

"It is the life of a parasite in the interior of the body which produces the malady commonly called '*choléra des poules*,' and which causes death. From the moment when this culture [*i. e.*, the multiplication of the parasite] is no longer possible in the fowl, the sickness cannot appear. The fowls are then in the constitutional state of fowls not subject to be attacked by the disease. These last are as if vaccinated from birth for this malady, because the fœtal evolution has not introduced into their bodies the material necessary to support the life of the microbe; or these nutritive materials have disappeared at an early age.

"Certainly we should not be surprised that there may be constitutions sometimes susceptible and sometimes rebellious to inoculation—that is to say, to the cultivation of a certain virus, when, as I have announced in my first note (*l. c.* pp. 239–248), one sees a preparation of beer-yeast made exactly like one from the muscles of fowls (*bouillion*) to show itself absolutely unsuited for the cultivation of the parasite of chicken cholera, while it is admirably adapted to the cultivation of a multitude of microscopic species, notably to the *bactéridie charbonneuse*. (*Bacillus anthracis*, Koch.)

"The explanation to which these facts conduct us, as well of the constitutional resistance of some individuals, as of the immunity produced by protective inoculations, is only natural when we consider that every culture, in general, modifies the medium in which it is effected; a modification of the soil when it relates to ordinary plants; a modification of plants or animals when it relates to their parasites; a modification of our culture liquids when it relates to *mucédines*, *vibrioniens*, or ferments.

"These modifications are manifested and characterized by the circumstance that new cultivations of the same species in these media, become promptly difficult or impossible. If we sow *chicken-bouillion* with the microbe of cholera, and, after three or four days, filter the liquid in order to remove all trace of the microbe, and subsequently sow anew, in the filtered liquid, this parasite, it will be found quite powerless to resume the most feeble development. The liquid, which is perfectly limpid after being filtered, retains this limpidity indefinitely.

"How can we fail to believe that by cultivation in the fowl of the attenuated virus, we place its body in the state of this filtered liquid, which can no longer cultivate the microbe? The comparison can be pursued still further; for, if we filter the *bouillion* containing the microbe in full development, not on the fourth day of the culture, but on the second, the filtered liquid will still be able to support the development of the microbe, although with less energy than at the outset. We comprehend, then, that after a cultivation of the modified (*atténué*) microbe in the body of the fowl, we may not have removed from all parts of its body the aliment of the microbe. That which remains will permit, then, a new culture, but in a more restricted measure.

"This is the effect of a first inoculation; subsequent inoculations will remove progressively all the material necessary for the development of the parasite.

"Is this the only possible explanation of the phenomenon? No, we may admit the possibility that the development of the microbe, in place of removing or destroying certain matters in the bodies of the fowls, adds, on the contrary, something which is an obstacle to the future development of this microbe. The history of the life of inferior beings authorizes such a supposition. The excretions resulting from vital processes may arrest vital processes of the same nature. In certain fermentations we see antiseptic products make their appearance during, and as a result of, the fermentation, which put an end to the active life of the ferments, and arrest the fermentations long before they are completed. In the cultivation of our microbe, products may have been formed the presence of which, possibly, may explain the protection following inoculation.

"Our artificial cultures permit us to test the truth of this hypothesis. Let us prepare an artifical culture of the microbe, and after having evaporated it *in vacuo*, without heat, let us bring it back to its original volume by means of fresh chicken *bouillion*. If the extract contains a poison for the life of the microbe, and if this is the cause of its failure to multiply in the filtered liquid, the new liquid should remain sterile. Now, this is not the case. We cannot, then, believe that during the life of the parasite certain substances are produced which are capable of arresting its ulterior development."

The last hypothesis advanced by Pasteur as the only alternative of the one first offered, seems to be disproved by the experiments cited, so far as chicken cholera is concerned; and in the case of vaccination we can hardly conceive that an antiseptic substance can be produced, during the development of the vaccine vesicle, in such quantity as to protect the individual for years, or for life, from the effects of the smallpox virus. We may, then, dismiss this hypothesis; but, as I shall endeavour to show shortly, this does not leave us without any alternative but to accept the hypothesis first offered, viz., the exhaustion of some material necessary to the development of the poison germ, bioplast, or whatever it may be, in the system of man or animals, by a single attack of any one of the specific diseases.

Let us see where this hypothesis leads us. In the first place, we must have a material of smallpox, and a material of measles, and a material of scarlet fever, etc. etc., for an attack of one of these diseases does not protect from any of the others. Then we must admit that each of these different materials has been formed in the system and stored up for these emergencies—attacks of the diseases in question—for we can hardly conceive that they were all packed away in the germ-cell of the mother and the sperm-cell of the father of each susceptible individual. If, then, these peculiar materials have been formed and stored up during the development of the individual, how are we to account for the fact that no new production takes place after an attack of any one of the diseases in question?

Again, how shall we account for the fact that the amount of material which would nourish the smallpox germ to the extent of producing a confluent case of smallpox may be exhausted by the action of the attenuated virus introduced by vaccination? Pasteur's comparison of a fowl protected by inoculation with the parasite of chicken cholera, with a culture fluid in which the growth of a particular organism has exhausted the pabulum necessary for the development of additional organisms of the same kind, does not seem to me to be a just one, as in the latter case we have a limited amount of nutriment, while in the former we have new supplies constantly provided of the material—food—from which the whole body, including the hypothetical substance essential to the development of the disease-germ, was built up prior to the attack. Besides this, we have a constant provision for the elimination of effete and useless products.

This hypothesis, then, requires the formation in the human body, and the retention up to a certain time, of a variety of materials, which, so far as we can see, serve no purpose except to nourish the germs of various specific diseases, and which, having served this purpose, are not again formed in the same system, subjected to similar external conditions, and supplied with the same kind of nutriment.

The difficulties into which this hypothesis leads certainly justify us in looking further for an explanation of the phenomenon in question.

This explanation is, I believe, to be found in the peculiar properties of the protoplasm, which is the essential framework of every living organism. The properties referred to are: the tolerance which living protoplasm may acquire to certain agents which, in the first instance, have an injurious or even fatal influence upon its vital activity, and the property which it possesses of transmitting its peculiar qualities, inherent or acquired, through numerous generations, to its offshoots or progeny.

There can be but little doubt that protoplasm is the essential living portion of the cellular elements of animal and vegetable tissues, but as our microscopic analysis of the tissues has not gone beyond the cells of which they are composed, and is not likely to reveal to us the complicated molecular structure of the protoplasm upon which, possibly, the properties under consideration depend, it will be best for the present purpose to limit ourselves to a consideration of the living cells of the body. These cells are the direct descendants of pre-existing cells, and may all be traced back to the sperm-cell and germ-cell of the parents. Now, the view which I am endeavouring to elucidate is, that during a non-fatal attack of one of the specific diseases the cellular elements implicated which do not succumb to the destructive influence of the poison, acquire a tolerance to this poison which is transmissible to their progeny, and which is the reason of the exemption which the individual enjoys from future attacks of the same disease.

The known facts in regard to the hereditary transmission, by cells, of acquired properties, make it very easy to believe in the transmission of such a tolerance as we imagine to be acquired during the attack, and if it is shown by analogy that there is nothing improbable in the hypothesis that such a tolerance is acquired, we shall have a rational explanation, not of heredity and the mysterious properties of protoplasm, but of the particular result under consideration.

The transmission of acquired properties is shown in the budding and grafting of choice fruits and flowers, produced by cultivation, upon the wild stock from which they originated. The acquired properties are transmitted indefinitely, and the same sap which on one twig nourishes a sour crab-apple, on another one of the same branch is elaborated into a delicious pippin.

Numerous examples in illustration of the same fact may be drawn from the animal kingdom; thus, the same mother may give birth to two children by different fathers; the one may inherit a predisposition to consumption, and the other to insanity; and this inheritance, which only manifests itself at the end of many years, has been transmitted from the original sperm-cells of the respective fathers through countless generations of cells which have lived and died, leaving their progeny to perform their functions.

The immunity which an individual enjoys from any particular disease

must be looked upon as a power of resistance possessed by the cellular elements of those tissues of his body which would yield to the influence of the poison in the case of an unprotected person. There is every reason to believe that it is upon the living portion of the tissues, or the protoplasm of the body, that the disease-poisons act; for if it were upon non-living matter—formed material, Beale—and we had to deal only with chemical phenomena, it would be impossible to account for the fact that like causes do not always produce like results. On the other hand, the resistance of living matter to certain destructive influences is a property dependent upon vitality. Thus, living protoplasm resists the action of the bacteria of putrefaction, while dead protoplasm quickly undergoes putrefactive changes. Again, it seems probable that in conditions of debility from age, sickness, starvation, or any other cause, the vital resisting power of the protoplasm is reduced, and certain agents which, under more favourable conditions, would be powerless for harm, may overcome this vital resistance.

The tolerance to narcotics, opium, tobacco, etc., resulting from a gradual increase of dose, may be cited as an example of acquired tolerance by living protoplasm to poisons, which at the outset would have been fatal in much smaller doses. There can be little doubt that in this instance it is the living protoplasm of the nervous tissues upon which the poison acts to produce its characteristic effects.

But it is in the specific diseases in which a single attack proves protective that I find the best proof that the cellular elements of the body may acquire a tolerance during the attack which being transmitted to their cellular progeny furnishes the protection which the individual enjoys.

Let us take a particular case. In yellow fever the immediate effect of the poison seems to be to arrest vital processes generally—nutrition, secretion, excretion—and in fatal cases we find that the protoplasm of various organs and tissues has undergone degenerative changes; this is especially true of the liver-cells. Now, we have every reason to believe that this occurs in a less degree in non-fatal cases, but that a sufficient number of cells having resisted the destructive influence of the poison, and become accustomed to its presence, resume their functions, and that thus the vital processes upon which the life of the individual depends are again carried on in the very presence of the poison, which at first paralyzed or destroyed the vital activity of certain cells. The case is more striking in smallpox, in which there is an undoubted increase of the poison in the tissues during the progress of the disease, but in the first-mentioned disease the patient commonly remains during his sickness in the infected atmosphere, the breathing of which produced the attack from which he is suffering.

The protection from yellow fever resulting from acclimation—if, indeed, there is such a thing as acclimation independent of an attack of the disease—seems to be a tolerance acquired by repeated exposure to the poison in quantities not sufficient to produce an attack.

The tolerance enjoyed by the negro race to the malarial poison is probably the result of long residence in malarious regions. Natural selection has doubtless come into play here in establishing this tolerance as a race peculiarity.

I would, then, place acclimation, inoculation by attenuated viruses, and an attack of any one of the specific diseases, all in the same category so far as the explanation of the protection afforded is concerned; and, according to my view, the explanation of this phenomenon is to be found in the peculiar properties of living protoplasm which enable it, within certain limits, to adapt itself to varying conditions and injurious influences, and to transmit the impression or modification received in so doing, to its offshoots, which continue to perform its functions during the life of the individual.

ARTICLE VII.

OÖPHORECTOMY FOR FIBROID TUMOURS OF THE UTERUS. By G. H. BALLERAY, M.D., of Paterson, New Jersey.

THAT oöphorectomy is destined to be the operation of the future in cases of bleeding fibroid tumour of the uterus, which has resisted all other treatment, which is not susceptible of removal through the vagina, and in which it is evident, that, unless the hemorrhage is arrested, the patient must inevitably perish, can hardly admit of a doubt.

The study of the natural history of cases of uterine fibroid has shown, that, after the menopause, it often ceases to trouble the patient, gradually dwindles away, and finally entirely disappears. It is therefore not to be wondered at that the idea should have suggested itself to surgeons to endeavour to bring about this condition artificially by the removal of the ovaries. It is often a difficult matter to decide upon the proper time for the performance of the operation, inasmuch as, in many cases, after the patient has been reduced to a condition of extreme anæmia from profuse hemorrhage, there is a temporary improvement, which is generally attributed to the use of some one of the fashionable remedies for these cases, which, in all probability, has nothing whatever to do with it. In consequence of these deceptive lulls, the operation is sometimes postponed until the patient is reduced to such a condition of weakness that any operation would be attended by more than the usual danger. The blind faith in drugs which some men exhibit, is to me incomprehensible. How an intelligent physician can go on month after month, pouring medicine into the stomach of a patient who is slowly but surely dying of hemorrhage from a uterine fibroid, is difficult to understand.

The hypodermic injection of ergotine is also sometimes persisted in for