favourable to their absorption, but it appears most reasonable to conjecture that some perversion of nutrition is the immediate step previous to their disappearance, on the universal principle that when nutrition fails, degeneration follows. I have frequently noted that, in cases of spontaneous absorption of fibroid tumours, an anæmic condition has preceded the change; and in regard to the woman whose case I have related, I attribute to her rapid pregnancies, her profuse and repeated floodings, the illness which followed the birth of her last child, and the ulterior mischief which attended her confinement, the present state of her womb.

We have other analogous phenomena in cases of extrauterine pregnancies, where the fœtus has been found reduced to its bony portions by the absorption of the other solid and fluid parts—the consequence of arrest of nutrition. The same thing has also been known to take place within the uterus, where a dead fœtus has been retained for a long time. It is further admitted that the placenta may become absorbed after delivery at term, and still more frequently after miscarriages. In none of these instances does degeneration and absorption commence so long as nutrition continues. How far we have a right to consider superinvolution the result of an inflammatory process—a theory which has been suggested—I am not prepared to say; but we are aware that inflammation causes an arrest of the “retrograde metamorphosis” subsequent to delivery; so that, to reconcile the two extremes, we must attribute to one action opposite effects. In the case I have given, however, there does not appear to have been any inflammatory mischief; and, as inflammation of the uterus is generally sufficiently well indicated, we have a right to presume that it never took place. I would just add that, supposing my explanation to be correct, and it to be a fact that in the case of this woman the usual fatty degeneration has proceeded to the usual extent, but that the process of reconstruction, owing to a poverty-stricken condition of the system, has been prevented, a practical inference is to be drawn from the circumstance, and it is possible that we may make the knowledge applicable to the removal of fibroid tumours by a system of lessening their nutrition by a restricted diet, and by other measures of a depletory nature.

THE GRAFT-THEORY OF DISEASE.*

By JAMES ROSS, M.D., Waterfoot, Manchester.

THE splendid experiments of Dr. Burdon Sanderson and of other workers upon virulent fluids prove that the active part of contagious matter resides in particles less than the one-twenty-thousandth of an inch in diameter, and very similar in their movements and in their physical and chemical characters to the organisms found in putrefactive fluids. The object of the present paper is to adduce some evidence to show that the particles of contagious matter are, notwithstanding their similarity to bacteria, not independent beings, but modified units of the individual from which they have become detached. It is impossible within the limits of a short paper to do anything more than present a small section of the evidence which can be adduced, either for or against such a proposition. It will be taken for granted, in the first place, that it has not yet been proved beyond doubt that the contagium-particles are independent organisms; since, if it were, the opposite hypothesis that they are only detached portions of a living individual would be at once inadmissible. On the other hand, since I cannot give experimental proof that the latter assumption is true, I must present evidence which will give it some degree of probability. The most obvious objection to this assumption is, that it is very improbable that a particle of one living body not larger than the one-twenty-thousandth of an inch in diameter, however much it may have been modified, should produce such extensive changes by its collision with another individual, as occur in the zymotic diseases. But this objection will be very much weakened, if not entirely removed, when it is remembered that the most wonderful process in nature is initiated by particles apparently as insignificant as these. I allude to the action of the reproductive particles in the genesis of new individuals. A closer examination will also disclose analogies between the reproductive and contagium-particles, which will give additional strength to the supposition that the latter are only modified portions of the individual from which they are derived. The contagium-particles, according to this supposition, are derivatives from epithelial cells; and both the germ-cell and sperm-cell, which by their union give origin to a new individual, are merely modified epithelial cells. The pathological changes which precede the detachment of the contagium-particles are such as to diminish

the supply of nourishment to the epidermis; therefore its units lose even the small degree of specialisation which enable them to take a share in the operations of the body of which they form a part, and hence they are cast off. But it has been supposed that the detached and semi-detached portions which are operative in the genesis of new individuals are highly “vitalised” products; and if this be the case, the analogy fails in one essential particular. But Mr. Herbert Spencer has shown that this latter assumption is very doubtful, and that it is probable that the reproductive cells are characterised by being unspecialised or by having undergone very little modification. In many plants, and the lower members of the animal kingdom, whose tissues are the least specialised, a small fragment of tissue is capable of reproducing a new individual. A hydra may be divided into fifty pieces, and each piece will grow into a new and perfect individual. In plants, the reproductive particles arise at the extremity of the axis, where the degree of the organisation is the least; and in the higher animals, the reproductive centres are, as already remarked, merely modified epithelial cells—cells which are remarkable for the simplicity of their structure.

We also find, as a rule, that the lower an organism is in the scale of organisation, the higher is its reproductive power. The fact that epithelial tissue is not highly specialised has just been referred to; yet it possesses the power of reproduction in a very eminent degree, even without concurrence with another organic particle. Mr. Herbert Spencer mentions the fact that a species of *Begonia* habitually develops young plants from the scales of its stems and leaves, and that many plants are developed by a single scale. These facts show that the reproductive particles are not highly specialised, and that in this respect they are similar to the particles detached from the body during the contagious diseases. That the contagium-particles become detached from the body at a time when they are sparingly supplied with nourishment, will not be doubted by anyone; and there is strong evidence to show that this is also the case with the reproductive particles. This is best seen with regard to the latter in those organisms where asexual reproduction takes place. Mr. Herbert Spencer adduces a great mass of evidence to show that, during the transition from asexual to sexual reproduction, there must be relative innutrition of the reproductive particles. When a *polype* is freely supplied with nourishment, it multiplies by a budding process; but when the supply of nourishment begins to fail, reproductive cells are formed, and sexual genesis takes place. A similar fact is known to gardeners with regard to fruit trees. Trees which are freely supplied with nourishment “run into wood,” and gardeners adopt the method of cutting the roots, and sometimes even go the length of “ringing the bark,” so as to diminish the flow of sap to the tree. After this expedient is adopted, asexual gives rise to sexual reproduction, the terminal buds become floral, and finally, the tree bears fruit. The reproductive particles, therefore, which, by their union, initiate the most wonderful process in nature—the evolution of a new individual—are, prior to their union, sparingly supplied with nourishment; and, as just noticed, the contagium-particles are detached from the body from a similar cause. There are, therefore, several agreements between the reproductive and contagium particles, and others might be mentioned; but I shall now proceed to mention one particular in which the analogy between them fails. In the genesis of new individuals by sexual reproduction, an union takes place between two particles detached or semi-detached from two distinct individuals; but in the genesis of a contagious disease, an union takes place between a distinct individual and a detached portion of another individual. But another series of facts is known to biologists where the analogy even in this respect is complete. I allude to the phenomena of grafting, where a portion detached from one individual is grafted upon another; and I shall now proceed to show that some of the phenomena which result from this process closely resemble those of contagion.

It may be remarked, that we must look for the agreements between the phenomena of grafting and those of contagion in the effects which are produced by the scion on the stock, since these are the most prominent features in the contagious diseases. Numerous examples of the effects produced upon the stock by the scion are mentioned by Mr. Darwin in his great work on *Animals and Plants under Domestication*, and in an interesting article in the *Popular Science Review* for April 1871 by Dr. Masters. I can only mention one or two of these examples. “Cases have been observed,” says Dr. Masters, “where, from the stock *below* the graft, fruits and flowers of the same appearance as those borne on the scion have made their appearance. This has been observed in the case of the pear grafted on the mountain ash, and in other cases.” “It is notorious,” says Mr. Darwin, “that when the variegated jessamine is budded on the common kind, the stock sometimes produces buds bearing variegated leaves. Mr. Rivers, on the authority of a trustworthy friend, states that some buds of a

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golden variegated ash, which were inserted into common ashes, all died except one; but the ash-stocks were affected, and produced, both above and below the points of insertion of the plates of bark bearing the dead buds, shoots which bore variegated leaves. Mr. Brown, of Perth, observed many years ago, in a Highland glen, an ash-tree with yellow leaves, and buds taken from this tree were inserted into common ashes, which in consequence were affected, and produced the blotched Breadalbane ash."

These instances must suffice here; but I am glad to say that both Dr. Masters and Mr. Darwin have noticed the analogy which exists between these phenomena and those of the zymotic diseases. "Adverting now to the effect produced by the scion on the stock," says Dr. Masters, "it may be said that we have here an operation something akin to vaccination." And Mr. Darwin says, "It is certain that, when trees with variegated leaves are grafted or budded on a common stock, the latter sometimes produces buds bearing variegated leaves; but this may perhaps be looked at as a cause of inoculated disease."

It has now been shown that there is a very close analogy between the phenomena of contagion and those of reproduction, and still closer between them and those of grafting. This is the reason why I have called the hypothesis advanced here the Graft-theory of disease. The question now is, how far this hypothesis will account for the phenomena of the zymotic diseases. I shall very briefly apply the hypothesis to the explanation of the phenomena of small-pox and of its allies; and it need scarcely be remarked that I can only seize at present upon the most prominent features of those diseases, without being able to enter into minute particulars. When a drop of vaccine fluid is placed upon a scratch in the arm, the effect produced is so well known that it is needless to describe it. This effect is said to be specific, and if by this be meant that the vaccine vesicle is different from what would be produced by any other agent, it is no doubt true; but if it be meant that the effect produced by the vaccine fluid has nothing in common with other morbid processes, it is not true. A chemical or mechanical irritant may be made to produce a pustule having many characters in common with the vaccine pustule. Passing over the disagreements in outward conformation between those pustules, the greatest difference between them is that the latter can produce its kind by inoculation upon a sound individual, while the former can not. But this difference is one more of degree than of kind, since ordinary inflammatory products frequently possess inoculable properties. Inflammation of the conjunctiva has been produced by inoculation with the discharge from ordinary ophthalmia; and the experiments of Dr. Sanderson show that inflammatory products may be made to assume highly contagious properties.

But inflammatory contagion declares itself not only by producing the disease upon a healthy individual, but also by spreading the morbid process within the organism of the individual first affected. We see surrounding any inflammatory centre a red areola, indicating that the morbid process is being communicated to the surrounding tissues; and if the primary inflammation be violent or prolonged, we also find enlargement of the neighbouring lymphatic glands, indicating an extension of the morbid process to these structures. But the process does not stop here. If the primary inflammation be still more severe, units of the morbid product enter the systemic circulation and produce inflammation in various parts of the body, especially in the internal organs. But this extension of disease from a primary centre—first to lymphatic glands, and second to other parts of the body—is not true only with regard to inflammation, but we meet with the same order of facts in syphilis, tuberculosis, and cancer. It is also very important to notice that whatever may be the nature of the primary morbid process, it tends to impress its own characteristics upon the disease of the glands and other parts of the body which result from it. In syphilis, for instance, the chronic induration which surrounds the primary sore shows itself in the chronic enlargement of the neighbouring lymphatics, and is more or less apparent in almost all the subsequent lesions which occur during the protracted course of the disease. A tuberculous gland and a cancerous tumour also each tend to generate their kind in the other parts of the body. Taking these facts along with us, we may now return to the consideration of the vaccine vesicle. On the fifth day after the insertion of the lymph, a red areola forms round the vesicle, and the neighbouring lymphatic glands begin to swell. Feverish symptoms also make their appearance about this time. On the tenth or eleventh day, the fever is at its height, and both the swelling of the glands and the red areola are greatest. The course of events so far, then, is not much different from what occurs in an ordinary pustule, except that the rapidity of the evolution of the vaccine vesicle is greater, and its intensity of action very much higher. We have found with regard to other diseases that the morbid process tends to spread throughout the organism; nor are we without evidence that such is the

case with the vaccine vesicle. What is known as Bryce's test clearly proves that as early as the fifth day the skin over the body has already undergone some modification, since the vesicle which results from a second vaccination performed on that day goes through its evolution so rapidly that it will be at its height, and will decline and disappear as early as the vesicles of the first vaccination. But the action of the vaccine vesicles on the organism at large does not stop here. About the eleventh day, a lichenous, roseolar, or vesicular eruption occasionally appears, which continues for about another week. These spots appear to be abortive vaccine vesicles which would, if the action were more intense, go through stages of evolution similar to those of the primary vesicle. This is rendered probable by the fact that, when a healthy individual is inoculated with small-pox matter, the secondary eruption appears about the eleventh day; and the vesicles of this eruption are similar in every respect to the primary vesicles. We have already seen that the secondary affections of inflammation, tubercle, and cancer, generally occur in the internal organs; but, in the case of small-pox, they occur in the epidermis. Why this should be the case, I cannot fully explain. This belongs to the speciality of the disease; and I wish at present to dwell upon the circumstances in which small-pox agrees with other diseases. One reason why the secondary affections should occur on the surface of the body in the contagious diseases is that, in any other case, infectious particles would not be cast off the body, and the disease would cease to be contagious. Natural selection, therefore, which acts in preserving diseased as well as healthy tissues, would preserve those particles which produced their secondary action on the surface of the body.

I cannot dwell further on the agreements between small-pox and the zymotic diseases generally and other diseases; but, in conclusion, I shall make a few remarks upon the difference between them. We have already remarked that the great difference between the vaccine and an ordinary vesicle is the rapidity and intensity of action of the former; and this is true, to a great extent, of the whole course of the zymotic diseases. Small-pox, for instance, goes through its evolution in a limited number of days, while tubercle and cancer require months or years to pass through their evolution. But rapidity of action means that the units of the morbid tissue are rapidly generated; and rapid multiplication of units involves a diminution of their bulk, since the same portion of tissue may consist of a few large or numerous small units. Rapid multiplication of units also renders free access of nourishment necessary; hence there must not only be abundant assimilable nourishment surrounding the units, but the cell-wall must either be very thin, or disappear, so as to allow it readily to permeate their substance. This disappearance of the cell-wall again renders the growth discontinuous—that is, the individual units are rendered independent of each other, so that they can disperse through the organism or become detached. The morphological characteristics, therefore, of highly infectious tissues are rapid multiplication and diminished bulk of units, great thinness or absence of the cell-wall, and discontinuous growth.

ON ETHER AS AN ANÆSTHETIC, AS A SAFER AND MORE EFFICIENT AGENT THAN CHLOROFORM.

By JOHN MORGAN, M.D., F.R.C.S.I.,

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THE question of the safety of ether as an agent in producing anaesthesia in surgical operations is one which may justly be considered of importance; and the claims which have been advanced on its behalf, both on the Continent and in America, where it has held its place for over a quarter of a century, deserve the attention of practitioners, who may have had reason, from practical experience, to distrust chloroform, or who may have found difficulty in overcoming the distrust which patients naturally feel in an agent which is accompanied by danger, and which has often instanced its subtle power by causing death under the most favourable circumstances, and where the greatest care had been taken to guard against any mischance. The reports which have been given even during the last week are particularly suggestive (BRITISH MEDICAL JOURNAL, October 5th), and must go far in condemnation of chloroform, and in increasing the nervousness as to its use both with the public and the practitioner, which is daily becoming more marked. We find that in one case, a lady aged 70, presumably healthy for her age, died "when very little chloroform had been used"; another case was that of a man (a hard drinker) aged 34, with whom three drachms of chloroform had been used; and *post mortem* examination revealed so little to explain death, that the question is fairly asked, "How are we to know beforehand that a patient cannot, without dan-