FUNCTION OF THE FLAGELLATED BODY.

Admitting, then, that the flagellated body is a living thing, a phase of the parasite, how may we explain its object? Observe that it does not come into existence until the spherical or crescent body from which it proceeds has left the body. Why is this? Because, as I have said, its purpose lies outside the body. It is found where it is wanted, and only there. And what is it wanted for? To carry on the life of the plasmodium outside the body. Observe from what phase of the intra-corporeal organism it arises. From a large, fully-grown, adult, intra-corporeal parasite, one which might very well to all appearance have proceeded to ordinary intra-corporeal sporulation. This is certainly the case in the quartan and benign tertian parasite; and it is in the highest degree probable that it is also the case in the crescent parasite, for it, too, is an intra-corporeal plasmodium—somewhat different in shape, it is true, but functioning in the same way, and therefore probably originating in the same way. Something has diverted these particular plasmodia from ordinary sporulation. What that something is I do not pretend to say, any more than the biologist can pretend to say what it is that turns one embryo into a male and another embryo into a female in other departments of Nature. Had the plasmodium gone on to sporulation in the ordinary way the peripheral portion of its body would have resolved into the ordinary intra-corporeal spores, and the pigmented centre been discarded as residual matter; but, being diverted from sporulating in this way by some occult cause, the peripheral portion of the organism is converted into flagellated spores, the central portion remaining as dead residual matter. The flagellated plasmodium I therefore regard as a sporulating plasmodium whose spores, for certain reasons in the interests of the extra-corporeal parasite, assume a flagellate form.¹

This view is strongly supported by what one sometimes sees in those spheres which stop short of flagellation. The accompanying is a sketch (Fig. 12) of one of these abortive

Fig. 12.

crescent-derived spheres from a case of æstivo-autumnal fever. It represents a very definite body. Originally a crescent-derived sphere which, failing to project flagella, gradually developed a ring of pale, spore-like spheres in what is usually the clear zone around the central circle of pigment. The matrix in which the clear spore-like bodies were located had a slightly brownish tinge, and so showed up these minute bodies with great distinctness. When perfect, the little spherules numbered about fourteen. After a short time they gradually merged into one another, the septum between them disappearing as if from degeneration. Does not this arrangement of spherules recall the rosette body of the ordinary sporulating plasmodium? And does it not suggest by the fact that it occurred in a crescent-derived sphere that this ring of spherules was a ring of coiled-up flagellated spores which, failing to erupt in the usual way, underwent some molecular or degenerative change which by slightly altering their refraction rendered them visible?

I conclude, then, that the crescent body, and the tertian and quartan spherical bodies which proceed to flagellation, are the extra-corporeal sporulating homologues of the intra-corporeal sporulating bodies; that the flagellum is the extra-

corporeal homologue of the intra-corporeal spore. Both types of sporulating plasmodium have corresponding functions, both arise from the same source; one is the germ of the plasmodium inside the human body, the other is the germ of the plasmodium outside the human body; both function in the propagation of the parasite.

Such is my view of the nature and significance of the flagellated phase of the malaria parasite, and some of my reasons for entertaining this view. In the following lectures I propose to point out how under natural conditions the potential flagellated plasmodial spore leaves the human body, and why this extra-corporeal plasmodial spore is flagellated. I shall then try to follow the parasite a little farther, and endeavour to indicate what I cannot but regard as part at least of the extra-corporeal life of the plasmodium malarie.

THE MILROY LECTURES

ON

THE VALUE OF ISOLATION AND ITS
DIFFICULTIES.

Delivered before the Royal College of Physicians of London.

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[ABSTRACT.]

LECTURE III.

THE DIFFICULTIES OF ISOLATION.

[AFTER discussing the influence of isolation on scarlet fever (which under present conditions was not controlled so efficaciously as might have been hoped), diphtheria (which appeared to increase in spite of sanitary measures), and measles, Dr. Seaton proceeded to deal with the difficulties of isolation. He said:]

OPPOSITION TO INFECTIOUS HOSPITALS.

First and foremost has been the growing dislike of land-owners and householders to the propinquity of "infectious hospitals." The opposition to the establishment of small-pox hospitals has been most violent. It is true that a distinction is made by the medical department of the Local Government Board as regards the dangers which attend the isolation of small-pox on the one hand, or the isolation of scarlet fever, typhoid fever, or diphtheria on the other. Still it is probable that the fear engendered by the numerous reports which have been made of late years as to the dangers of hospitals has not been without its influence in increasing the opposition raised to their establishment, or of "infectious hospitals" of any kind whatever. Certain it is that year by year the difficulties have increased to such an extent that some authorities, after numerous attempts, have felt inclined to abandon the project altogether. That such opposition should be kept within reasonable limits is a thing which authorities have a right to expect at the present day. In county districts the establishment of infectious hospitals is, I believe, practically without danger, and yet in some countries the attempts to provide them have been almost at a standstill.

HOSPITALS AS EXCHANGES FOR INFECTION.

By far the worst difficulty is that to which Sir George Buchanan specially refers in the Government report of 1881: the "misfortunes," as they are termed, which have occurred from time to time within infectious hospitals, that is to say, the accidental infection of persons with another disease than that for which they were removed. This constitutes, to my mind, one of the gravest difficulties connected with the system of isolation. Unless its extent be fully appreciated and unless the directions of medical officers be loyally followed by hospital or sanitary authorities, the isolation system, a valuable auxiliary to our preventive forces, may be jeopardised. For administrative reasons there are strong inducements to relax stringent rules as to admission of different kinds of diseases when there are vacant beds. I feel it therefore my duty in these official lectures to declare emphatically that it is vital to the whole question of

¹ I would venture to conjecture that all forms of the flagellated bodies proceed from conjugation forms, the result of multiple injection of a blood corpuscle—as Mannaberg maintains is the case in the crescent body; single injection of a blood corpuscle going on to the formation of the intra-corporeal sporulating body—intra-corporeal propagation, multiple injection of a blood corpuscle going on to the formation of the conjugated form, resulting in the flagellated body, extra-corporeal propagation. The fact of non-conjugation or of conjugation, determines the direction of development shall take. The relatively large size of the free flagella-forming sphere in tertian and quartan, and of the crescent body in æstivo-autumnal to the ordinary amebæ in their respective injections, would be explained by such an hypothesis. The mathematical figure of the crescent body I regard as the result of a mechanical rather than of a vital process.

isolation following notification that such medical rules should be upheld. We have seen that the town of Leicester has suffered from failure to appreciate them, and within the last five years I regret to say I have witnessed two examples of the spread of disease within hospital walls, under circumstances as to which the authorities had already been duly warned. With the example that we have of the difficulties which have arisen in the administration of laws relating to another great preventive measure—namely, vaccination—we cannot, I think, too strongly insist upon the absolute necessity of making hospital isolation, practically speaking, free from any risk. In the case of country hospitals we must rely mainly on good administration. As regards small-pox it is absolutely essential that the disease should be treated in buildings quite apart from all other infectious diseases; in the case of the other diseases which are intercommunicable—for example, scarlet fever, typhoid, diphtheria, measles, and whooping-cough—the rule should be that not more than two diseases should be treated simultaneously even in well-constructed hospitals with good administration.

In the case of the metropolis and very large towns it seems to me that the best policy is to insist upon separate hospitals for each of the principal diseases which the municipal authority is undertaking to isolate. Thus, for example, if the isolation of measles should be attempted, as I trust it will be on a large scale, it should be attempted only under fairly favourable conditions—that is to say, where the patients treated run no risk whatever of receiving any other infection. Along with these precautions against the intercommunicability of infectious diseases, experience dictates the absolute necessity of providing enough single room accommodation to allow the doubtful cases which may sometimes be sent to a hospital to be kept under observation for a suitable time. The arrangements at New York seem to be typical of what is best in this direction. There the cases of a doubtful character are isolated for a short time in separate rooms on the mainland near to the point of debarkation; it is not until the nature of the disease is quite declared that they are drafted to the special hospitals, which are situated on islands.

Whereas in "scarlet fever" the presence of the disease excites no particular terror, there will always be some cases kept at home which constitute foci of infection. There is no power for their compulsory removal to hospital, neither is it desirable there should be. But everything should be done by the authorities (without resort to extravagance) to render hospitals attractive.

THE CONSTRUCTION OF HOSPITALS.

Hospitals built at non-epidemic periods, where time can be given to the consideration of the various details as to site and construction so necessary to the complete success of a hospital for infectious diseases, form a striking contrast to those which are erected in a hurried manner. Although in 1881 there were reported to be 296 authorities provided with so-called hospitals, it is plain that at that time there were comparatively few that answered to the requirements of the Local Government Board, as set forth in a memorandum issued in 1888, reissued in 1892, and again in 1895, entitled *The Provision of Isolation Hospital Accommodation by Local Authorities*. The following extracts refer to some of the most essential points in the provision of such accommodation:

It cannot be too clearly understood that an isolation hospital, to fulfil its proper purpose of sanitary defence, ought to be in readiness beforehand, and during the progress of an epidemic it is of little avail to set about hospital construction. The mischief of allowing the infection to spread from first cases will already have been done, and this mischief cannot be repaired.

Large villages and groups of adjacent villages will commonly require the same sort of provision as towns; where good roads and proper arrangements for the conveyance of the sick have been provided, the best arrangement for village population is by a small building accessible from several villages.

In towns, hospital accommodation for infectious diseases is wanted more constantly as well as in larger amount than in villages, and in towns there is a greater probability that room will be wanted at the same time for two infectious diseases, which should be treated separately. For a town the hospital provision ought to consist of wards in one or more permanent buildings, with space enough for the erection of other wards, temporary or permanent. Considerations of intimate economy make it wise to have permanent buildings sufficient for somewhat more than the average necessities of the place, so that recourse to temporary extensions may less often be necessary. In any case it is well to make the adminis-

trative offices somewhat in excess of the wants of the permanent wards because thus at small additional first cost they will be ready to serve when occasion comes for the wants of temporary extensions.

Speaking generally, it has been estimated that the provision of one bed per thousand inhabitants is sufficient for the permanent requirements of a sanitary district, but such requirements will necessarily vary with the character of the population. Even in a locality where the population is well-to-do, and most houses of a size and construction that offer reasonable facilities for the isolation of single attacks of the current infectious fevers, the amount of accommodation needed for public health purposes will be less than in a manufacturing or colliery district, where infectious disease cannot be treated in the houses where it breaks out without very great danger or certainty of its spreading.

Plans, copies of which I exhibit, accompany the memorandum of the Local Government Board, which relates chiefly to the construction of comparatively small hospitals, at the outside not more than 25 or 30 beds, that is to say, for populations of small towns or groups of villages. In the case of larger towns, the same essential points have to be taken into consideration, and the plans which I am able to show you, some of which are taken from the well-known work by Messrs. Gordon Smith and Keith Young, in Stevenson and Murphy's *Hygiene*, and others from the valuable paper on *Fever Hospitals*, by Mr. W. Aldwinckle, read at the Royal Institute of British Architects about a year ago, will make it clear that the large hospitals such as those in and about the metropolis, and at Glasgow, Newcastle-on-Tyne, at Salford, Nottingham, and Derby, as well as those at Buda-Pesth, Berlin, and other great cities of the Continent, consist mainly of a multiplication of blocks or pavilions, of which the small hospital may be said to be the unit.

If time allowed, it would be interesting to discuss the questions of detail which are not unimportant, as for example, the desirability of having covered ways connecting the various blocks and pavilions, which are of importance from a public-health point of view. It would be especially interesting, also, to discuss the question of cost per bed, and the necessity or otherwise of certain structural arrangements, such as those which frequently add to that cost. I must, however, in view of what I have still to say, confine myself entirely to questions of principle, leaving the details to be amplified at a subsequent period.

THE ISOLATION HOSPITALS ACT.

The administrative difficulties of providing what might be called a hospital for separate small village communities have already been adverted to in the memorandum of the Local Government Board. It was in view of these difficulties that Lord Thring, in 1893, succeeded in carrying a very valuable measure called the *Isolation Hospitals Act*. This Act was passed with a view to enable counties to form what is called "hospital districts" in any such extended areas as would be conducive generally to efficiency as well as economy. The Act would have been very much more efficacious but for its limitations; thus it does not apply at all to boroughs having a population of over 10,000, except with their consent. This is a considerable difficulty, and it arises from what is called the "spirit of local self-government," which, when it is allowed to come into play in the case of very small towns, is rather obstructive. Each authority, even in the matter of the provision of hospital accommodation, desires to be independent, but the gratification of this desire is apt to make hospital accommodation much less efficacious or much more costly than might otherwise be the case in country districts. In the case of large towns the question of cost has not as yet assumed the proportions of a difficulty, except in the metropolis, where the estimated cost per bed has, I am credibly informed, gradually risen to something like £500 per bed. I need not say that everything should be done to make hospitals attractive, but it is evident that there must be some limit to the cost entailed in the provision of hospitals, if they are to be multiplied at the expense of the ratepayers. It has been estimated that in country districts an average cost of £200 to £250 per bed is a fair amount for the provision of the necessary accommodation.

THE HOSPITAL AS AN OFFSHOOT OF THE DWELLING.

On the other hand, the trend of public opinion seems to be unmistakably towards finding accommodation for sick persons, not necessarily paupers, who cannot be properly housed as sick persons should be, otherwise than at the public expense. It is this tendency in popular opinion that

counterbalances the above considerations, inasmuch as it is very largely responsible for the development of our existing hospital system.

Our own College had a large share in the initiation of a demand for better accommodation for the poorer classes. In the words of the celebrated Memorial moved by Dr. Anstie in 1874:

Physicians are brought much into contact with the poorer classes of the population, and are deeply interested in anything that concerns the welfare of these classes, not only on account of the poor themselves, but also because the evils engendered among them affect the whole of society It is well known that overcrowding, especially in unwholesome and ill-constructed habitations, originates disease.....

Rate-supported infirmaries and hospitals (I do not speak at the moment only of hospitals for infectious diseases) for the benefit of those whose living accommodation is too confined, when sickness appears in the household or family, are by some political economists regarded as a necessary result of the overcrowding of the population in large towns. It is from this point of view that the important subject of hospitals has lately been discussed. Messrs. Gordon Smith and Keith Young, architects of great experience and ability (the former of whom has for many years been the responsible adviser of the Local Government Board on the question of by-laws, plans, and buildings, hospitals, etc.), review the dwelling accommodation of the population of the United Kingdom. They show that with the great mass of the population of towns neither isolation nor decent nursing is possible, and that hospitals are therefore the necessary offshoot of the dwelling.

So also in country districts it is felt that hospitals are a necessity if the children of poor people are to have a fair chance of recovery from sickness. How impossible this must be under present conditions may be gathered from a recent report by the medical officer for Derbyshire (Dr. Sidney Barwise), who, in writing about the progress made in hospital provision, makes the following interesting and important statement:

In 1879, 296, or about one-fifth of the 1,510 provincial sanitary authorities, possessed some means of isolating cases of infectious disease, and that between that date and 1891, loans amounting to £448,769 had been granted to 100 authorities for the provision of isolation hospitals, so that in 1891 about 400 of the 1,510 authorities had made provision for their district, but more than two-thirds were without any means of isolation whatever. In some parts of the country not even that proportion of authorities are provided. For instance, in Derbyshire, out of a population of 426,768, only one district (Buxton), with a population of 7,500, has erected a permanent isolation hospital. That there is urgent need of them is apparent from the fact that over 5 per cent. of the tenements in the county have only two rooms, and between 10,000 and 11,000 families in the county occupy three rooms or less, so that the plea that there is not the necessity for isolation in country districts cannot for a moment be upheld.

We are, however, very far as yet from having reached the stage at which the general right to free hospitals can be said to be established, but in connection with isolation of infectious cases the problem may be said to have been worked out during the last twenty years. The infectious isolation hospitals of the metropolis and large towns are free to all cases; there is now no trace of the stigma of pauperism attached to their use; admission can be obtained for any sufferer provided there is a bed to spare.

The position of things has, therefore, undergone a wonderful change since 1872. The isolation hospital accommodation of this kind had only just been originated, and was limited to some thousand beds for a population of three millions. It is calculated that the present hospital provision of this kind for the metropolis amounts to 6,000 beds, considerably more than the 1 bed per 1,000 of the population, which is laid down by the Local Government Board as the standard requirement. With the multiplication of hospitals, due to the development of the isolation system, and especially stimulated by the introduction of the Notification Act in 1889, there has been a gradual disappearance of the signs of a pauper character attaching to the institutions. These have been replaced by the characteristics which distinguish our great voluntary hospitals, not the least important of which is the admission of students, who have the opportunity of regular courses of instruction in the hospital wards. In bringing about these great changes, the College of Physicians and the metropolitan Society of Medical Officers of Health had a large share.

In the lectures which I have had the honour to deliver be-

fore you I have endeavoured to describe impartially the evidence relating to the value of isolation, and at the same time to fairly represent its difficulties.

If the country generally should follow the example of the metropolis in respect of hospital provision, especially for infectious diseases, the isolation of which is, I believe, important to the public health, it will surely be spending money wisely and well. The evidence that I have submitted to you in the course of these lectures shows unmistakably that the lives of breadwinners depend on this new method of insurance; it shows that the health and strength of the rising generation must also in a large measure depend on the facilities for complete recovery which, in the case of the vast mass of the population, hospitals can alone afford.

THE FUTURE OF SANITARY ADMINISTRATION.

Human life is the most valuable kind of property. It is for "medicine" to say how it may be preserved in "public" as well as in "private" affairs of health. As I commenced these lectures by referring to the physician's influence and work in the politics of health, I will now conclude by quoting the words of a master on the subject:

For the further development of our sanitary institutions and their working, the educational onward influences may be expected to come from the members of the medical profession, and are perhaps not in any essential sense to be expected largely except from them. This is not meant only with regard to the abstract science of the matter, but equally with regard to administration. Regarding the science it has long been evident enough that for such new researches and observations as will supply increase to the body of exact knowledge on which the prevention of disease depends, the world cannot expect much help except from the work of the medical profession; and the same is now constantly becoming more and more clear in regard of Public Sanitary Administration.¹

THE PHYSIOLOGY OF THE CARBOHYDRATES.

A REJOINDER TO DR. PATON'S FURTHER CRITICISM.

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(Continued from page 586.)

THE question, in comparison with which all other points are of secondary importance, is whether it is possible for sugar, in accordance with the glycogenic theory, to reach the general circulation for transit to the tissues to be consumed in them, without an indication of such transmission being afforded by the urine. Experience shows that under normal conditions the urine is not influenced by the carbohydrate matter ingested; yet, of necessity, the carbohydrate is in some way or other disposed of. Carbohydrate matter which reaches the general circulation in the form of sugar gives evidence of so doing by passing into the urine. Since the carbohydrate matter of the food produces no effect upon the quantity of sugar in the urine, the natural conclusion is that the carbohydrate of the food does not reach the general circulation as free sugar. In diabetes the condition is the converse of that observed in health. The urine no longer remains uninfluenced by the carbohydrate matter of the food, but contains sugar in proportion to the carbohydrate matter ingested. As a corollary, since the urine is influenced, the blood of the general circulation must be influenced similarly, for the sugar which gets into the urine is derived from the blood. The fundamental difference between health and diabetes is that in the former the blood of the general circulation and, in consequence, the urine, escape becoming charged with sugar, while in the latter they do not escape. Obviously, therefore, a "stoppage action" must be exerted in the one case which is not in operation in the other. What is necessary in order to maintain the condition of health is the exercise of this "stoppage action."

First in my *Physiology of the Carbohydrates*, and subsequently in my *Epicriticism*, I have entered fully into a discussion of the conclusions which must be drawn from a consideration of the relation of the blood to the urine in connection with this question. To show in what position the matter stands I will here give a quotation from my *Epicriticism* (p. 59 *et seq.*):

Observation from every point of view shows that the urine affords an index of the state of the blood in relation to sugar. No one will dispute that the sugar of urine is derived from that previously existing in the

¹ *English Sanitary Institutions*, p. 473 (Simon).