carrying out this popular method of dealing with what was formerly an intractable condition.

The last chapter groups together all the various conditions for which injection treatment may at times be used. These include hydrocele, varicocele, bursa, hernia, &c.

The question of the cure of hernia by these methods is treated with wise restraint, but it is clear the author considers that in selected cases the treatment may be of value.

This little book is excellently printed and free from typographical errors. There is a good index and each chapter has a complete bibliography.

It can be recommended as a useful addition to the library of all doctors.

J. W. W.

Correspondence.

THE NATURE OF VIRUS AGENTS.

TO THE EDITOR OF THE "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

Sir,—May I be allowed to supplement my recent paper on the above subject (this Journal, vol. xlix, pp. 263, 343) with certain further considerations which are of importance? In a recent number of the Lancet (December 10, 1932, p. 1285) it was pointed out that the size of the particles constituting various strains of bacteriophage have been fairly closely determined by means of the collodion-membrane filter. They have been found to vary from a minimum of 8-12 millimicrons (\( \mu \)) up to a maximum of 50-70\( \mu \); that is to say, from 0.008-0.012\( \mu \) up to 0.05-0.07\( \mu \). The virus-particles of foot-and-mouth disease also are stated to fall within the same range of size. Now the molecule of haemoglobin is estimated to be about 30\( \mu \), or 0.03\( \mu \), roughly mid-way between the two extremes given. This substance, however, complex though it is, is probably by no means so elaborate in molecular constitution as the nucleins and nucleo-proteins, whose composition has yet to be ascertained. And, certainly, neither haemoglobin nor even the nucleo-proteins can be said to be living matter, with the properties and functions of life. Is it in the least degree likely, therefore, that the bacteriophage and the virus of foot-and-mouth are animate—in other words, organisms? Further, foot-and-mouth is a typical animal virus disease. The respective causes of other virus-diseases are, almost certainly, a similar type of thing to the agent causing foot-and-mouth. What applies to one, applies logically to all.

Another point to which reference may be made is that there has been a tendency latterly on the part of some (e.g., J. S. Haldane), in order to overcome the difficulty arising from the invariable, obligatory association of these virus-agents with cells, to consider the cell (or cytode, as the bacterial body may be termed) as not being the indivisible unit
of life, but as consisting of, or at any rate containing within itself, minute units, which are themselves alive. In other words, a cell is regarded as being, really, a colony of lesser units. This is, in my opinion, a very far-fetched and unlikely assumption. As I have said elsewhere (Lancet, 1930, i, p. 211), "in any particular living thing, whether one of the lowliest cell-units, such as a bacterium, or a highly differentiated one, a congeries of which make up the body of a multicellular animal, we have not the slightest evidence that, in such a unit, there are contained lesser or simpler elements which subscribe to the definition of life." If the minute elements under discussion were indeed animate, we should almost certainly find them, or forms corresponding to or representing these "micro-micro-organisms"—and probably in abundance—free in nature; just as we find animals consisting each of a single cell, homologues of the colony of which the metazoan body is built up. Yet no one has ever observed anything like them! Neither can any fermentative action, or metabolic changes of any kind, indicating nutrition of animate matter, be noted in any cultures or preparations, which have been freed from living organisms conforming to the accepted definition. This particular objection has been already raised, indeed, by Boycott (vide second reference given above). Is not this fairly conclusive evidence against such a view?

As has been clearly shown, therefore, every consideration, whether biological or microscopical, which has been discussed, points unmistakably to the actual causative agent of these various viruses being, not a living organism, but rather some enzyme or ferment produced pathologically by cells. In the case of the smallest-known particles with which the power of acting as a virus is associated, such as those of the bacteriophage, foot-and-mouth, transmissible fowl-sarcoma, it is not unlikely that these represent, respectively, the actual molecules of the particular enzyme concerned in nearly a pure state, i.e., adsorbed on to an extremely minute quantity only of extraneous colloid material (substrate). Starling has said, in his "Principles of Human Physiology," that "it has hitherto proved impossible to obtain any preparation of any enzyme which can be regarded as a pure substance," because of the tendency of enzymes, which are themselves colloidal or semi-colloidal in nature, to adhere to colloidal matter. These remarks apply, of course, to the digestive enzymes contained in the various digestive juices, which indeed come almost in the category of solutions! And the above-named viruses are to be regarded as approaching near to this end of the scale. On the other hand, in many viruses, such as those of vaccinia, herpes, the "Rickettsia"-diseases, etc., the enzyme cannot be separated from comparatively conspicuous particles of colloid matter, of relatively appreciable size. In many cases, this colloid material seems to have a minimal size-limit of 0.2-0.25μ (in the stained condition). The various examples given by Coles and Merlin, in the paper I cited, are illustrative in this connection.

This difference is probably of considerable physiological importance in
regard to the behaviour of the virus in different cases. Because, in the
former type, it may be expected that the ferment will be diffusible and
capable of being passed out of the affected cell, i.e., secreted extracellularly.
Whereas, in other cases, where the ferment only occurs adsorbed to the
larger, readily manifest particles of colloid matter, its properties as a virus,
in regard to diffusion, sedimentation, etc., will be or may be markedly
different. A few examples will make this clear. Where the action of the
ferment is entirely intracellular, as probably in the case of ordinary, non-
glandular epithelium, the virus will not be liberated until the cell dies and
disintegrates and the particles of the altered, or abnormally digested,
material are scattered. Even where the abnormal ferment is secreted
extracellularly, as, for instance, in the case of the intestinal epithelium of
the louse, it may be at once adsorbed on to the liquefied haemoglobin and
hence not separable from the "Rickettsia"-bodies. In special cases, where
particular types of cell are concerned, both conditions may be found. Such
a combination most probably occurs in the case of hydrophobia, where, on
the one hand, the virus will be adsorbed on to the Negri-bodies and the
particles into which these become fragmented occurring in certain nerve-
cells, and on the other hand will also be present, in the nearly pure state,
in the diffused secretion of the salivary glands. (As I indicated in my
paper, I have reason to think that, now and again, the abnormal enzyme
may also be passed out of certain nerve-cells.) If these considerations
are borne in mind they may help to explain some of the contradictory
results reported in experimental and Pasteurization-work upon this virus.

Crosswyn,
Walton-on-Thames.

I am, etc.,
H. M. Woodcock.

Notice.

THE ROYAL SANITARY INSTITUTE.

A course of practical training for intending candidates for the
Examination for Inspectors of Meat and Other Foods will commence
at the Institute on Friday, February 10, 1933. Full particulars can be
obtained from the Secretary of the Institute, 90, Buckingham Palace
Road, London, S.W. 1.