material available in the special hospital and in the 600 additional beds of the adjacent Medical College group of hospitals.

The new Institution is evidently destined to take a leading place in scientific medical research and teaching in the British Empire.

## Virus Diseases of Plants.

HUMAN pathology has naturally had first claim upon the services of the investigator of disease, but a study of plant diseases is probably equally essential to human progress, and the timely review in *Science Progress* (No. 67, January 1923), by Dr. E. J. Butler, director of the Imperial Bureau of Mycology, bears eloquent witness to the great activity with which the special problems of plant pathology are now being attacked. It was only towards the close of the last century that the propagation of disease in plants was shown to be effected in some cases by a filterable virus, but since then facts and theories as to virus transmission have followed in rapid succession from various Continental and American laboratories. Very few observations have so far come from British laboratories, and it may be hoped that the very comprehensive and critical review presented by Dr. Butler will direct more attention to this fascinating field of work.

Many obscure conditions prevailing among growing plants should receive elucidation as a result of investigation into this problem, while the facilities the plant provides for experimental work may enable the whole mechanism of transmission by a virus to be submitted to a very critical analysis. For more than a century it has been known that in certain cases of variegation, if a branch bearing variegated green and white foliage be grafted upon a plant of the same species with normal green foliage, the variegated habit will slowly extend to the branches formerly bearing normal green leaves. This type of "infectious chlorosis" is still of obscure origin, and in this case, as with the curious "peach yellows," investigated in the United States, and in the "spike" disease of the sandalwood tree in India, grafting appears to be the only artificial method of transmission. All these puzzling abnormalities, varying from innocuous variegation to serious diseases such as the "spike" disease, which threaten to extinguish a profitable crop, may receive elucidation through the study of virus diseases more amenable to experimental treatment.

Among the diseases suitable for investigation, perhaps the best known are the "mosaic" diseases, so called from the patchy discoloration they usually produce upon the plant surface. Tobacco mosaic provides a remarkable case of transmission by a highly infectious virus which has been very thoroughly examined by H. A. Allard in the United States. In this case, if the hairs upon an infected plant are carefully cut with a sterile scissors, infection may follow if the hairs upon a healthy plant are then cut with the contaminated scissors. Originally considerable support was given to a theory that the infectious principle in tobacco mosaic was enzymic in nature, but Allard showed that, although ultramicroscopic, the infectious substance could be removed from the expressed plant juice by filters that left the oxidase activity of the juice practically unimpaired. However, the strongest argument in favour of an organism is furnished by dilution experiments in which the expressed juice, diluted to 1 in 10,000, still retains infectious properties. One of the most puzzling properties of the tobacco virus is its extraordinary stability to chemical reagents usually very toxic to living protoplasm and its resistance to relatively high temperatures. In the absence of any information as to the life-history of the invisible parasite it is impossible to correlate this resistance with any special growth form.

The invisibility of the organism sets an upper limit to its size in accordance with the resolving powers of the microscope; experiments with bacterial filters, in view of their tendency to clog, do not permit a lower limit of size to be assigned with confidence, while, on the other hand, the way in which a mycetozoan plasmodium will filter through a cotton-wool plug, cleaning itself from ingested food particles in the process, suggests caution in considering passage through a filter a proof that the natural diameter of the organism is smaller than that of the pore of the filter.

Although a filterable virus was first demonstrated as a cause of disease in the case of the tobacco mosaic, plant pathology is not so far advanced in its study of the organism as human pathology.

One great difficulty is that the culture of the organism outside the plant has so far proved impossible; in this respect these are as confirmed pathogens as the well-known group of rust fungi. Some of the virus diseases, as potato leaf-roll, net necrosis of the tuber, etc., seem to propagate only within a special tissue, the phlœm. This is worthy of consideration when attempts are made to cultivate the organism on artificial media, as the phlœm is relatively alkaline in reaction and both cell walls and contents are probably very distinctive in chemical composition.

Many of these virus diseases are propagated by insects, and Dr. Butler discusses critically the evidence which has been brought forward to explain the greater success of transmission when the plant cuticle is pierced by the insect rather than by needle or knife. One interesting possibility is the need for a necessary part of the life cycle of the pathogen to be completed in the insect carrier, but more work is also required upon the natural healing of punctures caused by insects and by instruments. The manner in which some aphids are also alleged to puncture always in the neighbourhood of the phlœm also provides a very interesting problem for further observation and experiment.

One interesting result of this work is the considerable significance it gives to the aphis as a carrier of plant diseases. At the International Potato Conference held under the auspices of the Royal Horticultural Society in November 1921, Mr. A. D. Cotton pointed out how the recent work of Quanjer in Holland and Schultz and Folsom in the States emphasised the importance of the relative intensity of aphides and possibly other insects in the propagation of leaf-roll. This disease, which is of very great economic importance, seems to spread from plant to plant chiefly in districts where the aphis-attack is general early in the season. As a result, the disease is transmitted very extensively in the warmer English counties, while in the Northern Scottish counties its spread may be little or nil, coincident apparently with the relative absence or late development of aphis infestation. This is very suggestive in relation to the proved value of Scotch seed-potatoes, and this important problem alone, with the new light it throws upon the principles to follow in seed-selection, would justify the extensive exploitation of this comparatively new field of scientific investigation.